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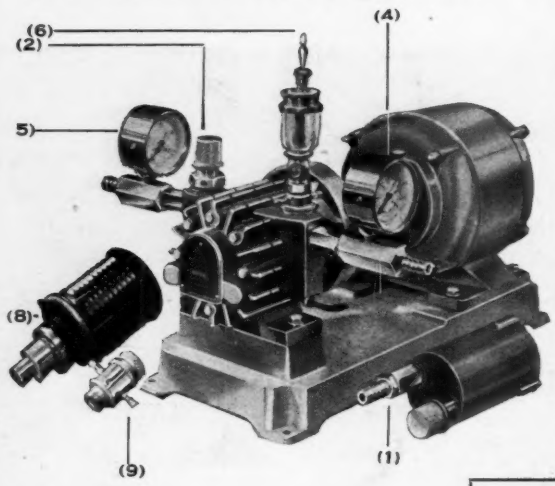

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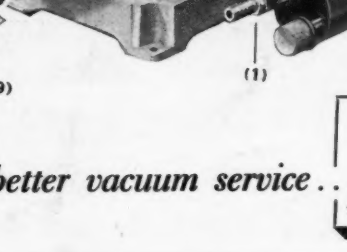

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INDUSTRIAL RESEARCH ASSOCIATIONS AND THEIR FUNCTIONS

ALTHOUGH the Department of Scientific and Industrial Research has from its inception acted as a watch-dog on the expenditure of public money on the industrial research associations of Great Britain, for long its main concern has been to encourage research in industry and to make industry realize how vital research is to its survival. The success which has attended the Department's efforts in that direction has in itself led to a more critical view of the work of the research associations, and such an attitude has in recent years been encouraged by the realization of the demand which the work of about forty research associations inevitably entails on the limited scientific and material resources of the country during the post-war years. The demands of the rearmament programme and the present financial stringency have both contributed to sharpen that attitude, though it is still true to say that the question of the most appropriate use of scientific and material resources is far more important than the purely financial aspect.

The report on the work of the British Leather Manufacturers' Research Association for the leather industry, which has recently come from a Survey Panel set up by the Department of Scientific and Industrial Research in November 1950 to review the resources, facilities and programme of the Research Association in relation to the scientific, technological and economic needs of the industry*, is a new and welcome departure, but one clearly foreshadowed by comments of the Advisory Council in the Department's annual report for 1948–49, and indeed earlier by some observations in the third report of the Advisory Council on Scientific Policy in 1950. As Sir Ben Lockspeiser, who himself acted as chairman of the Panel, indicates in a foreword, it is a sample survey conducted to determine also the validity of this means of correlating research with economic needs and assessing the appropriateness of the balance of effort between fundamental research, information and day-to-day services, and applied science in a particular industry. The survey records the history and achievements of the Research Association during the past thirty years, reviewing the organization of the industry and its scientific and technical background. Although membership of the Panel was largely drawn from the Department of Scientific and Industrial Research and from the Research Association itself, its membership was sufficiently comprehensive of all interested parties to give full weight to its discussion of major economic problems; it was also able to assess the opportunities for improvement and the bearing of the work of the Research Association on the economic needs of the industry, as well as on the recruitment, training and employment of technologists. Moreover, besides being represented on

* The Work of the British Leather Manufacturers' Research Association. The Report of a Survey Panel of the Department of Scientific and Industrial Research. Pp. 61. (The Association, Milton Park, Egham, Surrey, 1951.) 5s. net.

the Panel itself, the United Tanners' Federation and the British Leather Federation made substantial contributions to the final report.

Glancing first at the growth of the Research Association itself, the survey notes that while the Research Association had 207 full and 71 associate members, with a graduate staff of 25 and an income of £47,000 in 1950, its membership still represents only 50 per cent of the production of the industry. Nevertheless, past work of the Association is estimated to be benefiting the industry to the extent of some £300,000 per annum, of which £125,000 is attributed to the maintenance of quality of heavy leather production and £70,000 to the use of the paraffin degreasing process. Ultimate savings in upholstery leather and in bookbinding leather are put at £35,000 and £50,000 annually, respectively. The present distribution of effort is estimated by the director as 30 per cent on fundamental research, 24 per cent on liaison, 21 per cent on processes, 13 per cent on raw materials and finished products and 7 per cent on library and information. The 3·5 per cent expended on productivity and 1·5 per cent on machinery are expected to increase as the work of the recently formed engineering section develops, and it is estimated that the thirteen major items in the Association's present programme offer eventual annual savings of £500,000 for their annual expenditure of £29,000. To carry out its present urgent programme of work, however, the Research Association needs to double its present subscription income of £30,000, drawn from an industry with a turnover of £87 million and a wage-roll on production alone of nearly £9 million.

Although the Survey Panel did not investigate, as did Prof. R. S. Edwards in his recent study of the economic aspects of the research associations, the reasons for the inadequate financial support which the Research Association receives from the industry it serves, some attention was given to the possibilities of increasing the membership. It is frankly admitted that the effort of the Research Association tends to be spread too thinly over too many subjects, and some pruning of the programme is recommended as necessary to do justice to the needs of the industry. There are severe limits on what could be done to attract new members by seeking to satisfy too many. This is a problem common to research associations, and the Survey Panel rightly emphasizes the importance of selecting the right problems and concentrating effort on a limited number of items of outstanding technological and economic importance in each major section of the industry.

Provided that adequate resources are available to tackle the selected projects, this in the long run is the surest way of attracting support; and not the least merit of this survey is the challenge it throws down to the industry to criticize or approve of the selected targets. If the selection is at fault and the reasons given for their selection are unsound, no section of the industry can disclaim responsibility for pointing out exactly where misjudgment has occurred; and the responsibility lies on the non-member as much as on the members of the Association. Apart from this, the Survey indicates clearly the sections of the industry where the Association is most poorly supported, and the Council of the Research Association is already considering what could be done to meet the special needs of these sections. Other possibilities of increased support are visualized among the fellmongers of foreign or imported skins or of domestic pelts, among tanning extract manufacturers and among makers of dyes and finishes; but the survey's estimate that the total expenditure by the industry on research and development is not more than five times the £50,000 expenditure of the Research Association suggests that the industry has a long way to go before it can be described as being, in any adequate sense, research-minded.

For this position, another factor besides the very small size of most of the firms which are non-members may be responsible. Including in its survey the recruitment, training and position of technologists, the Panel reached the conclusion that the supply both of scientific men and of technologists is inadequate for the needs of the industry. The absence of a sufficient number of such trained minds capable of recognizing both the significance of new advances and the problems which require investigation can impede both the furtherance of research itself and utilization of existing knowledge. It is not clear from this Survey whether the Research Association finds difficulty in recruiting the staff it needs, but in the establishments at Leeds, London and Northampton the leather industry appears to be well provided with institutions capable of training the technologists required. On the evidence of the present report, there may well be less need in the leather industry than in some others for the Research Association to contribute in this direction by interchange of staff. None the less, the educational function of the Research Association will evidently be important for a long time to come; and apart from the question of selecting the right projects for research, the distribution of research effort must be constantly scrutinized from the point of view of educating the industry as to the importance of research.

The core of this report is the analysis of the distribution of the effort of the Research Association which is given as Appendix I, and the attempt made therein to assess the value of past and present work. This review has, of course, to be set beside the examination of the present economic problems of the industry contained in the body of the report, where stress is laid on the scope for savings afforded by the avoidance of warble damage to hides and in the improvement of flaying and salting of hides, calf skins and sheep pelts. It is estimated that damage to the extent of about £500,000 could be prevented with reasonable care, and a further recommendation in this section of the report is that the Council of the Research Association should consider further the proper scale of research and development work in both natural and synthetic tanning materials—a development which might hold possibilities of further support from the tanning extract manufacturers.

Looking at the past and prospective research programmes of the Research Association, the review suggests that about 50 per cent of the fundamental work is of the long-term type, which will ultimately be published in periodicals devoted to pure and academic research; the remainder is expected to modify the approach to applied subjects within five years. Viewed as a whole, the Association's main effort is undoubtedly directed towards increasing control over existing processes or improving them generally; even the 12·6 per cent of effort devoted to raw materials and finished products is also mainly concerned with existing processes. This distribution is not seriously challenged by the Survey Panel; besides the suggestion regarding the development and evaluation of new natural and synthetic tanning materials and new methods of tanning already noted, its only concrete proposals are for consideration by the Council of the continuation of work on the advantage or otherwise of accelerating the vegetable tannage of heavy leather, and for greater effort towards finding new processes, or radical alterations to existing processes. It is suggested that the latter in particular might be welcomed by some of the larger firms. As example, it cites the improvement of the abrasion and wear resistance of sole leather, particularly in view of the development of American resin rubbers, which do not absorb moisture from the feet and also possess greater abrasion resistance than leather.

The future prosperity of the leather industry in Britain may well depend on the prosecution of far-sighted investigations of this type, and in detailing and analysing the research plans and programmes of the Association with such frankness, the Department of Scientific and Industrial Research has gone well-nigh as far as can reasonably be expected to show what return is being received from this annual expenditure of some £20,000 of public money. Any suggestion that such expenditure has been neither wise nor worth while must in future be sustained by pointing to projects upon which effort has been injudicious or wasteful, and also by constructive proposals for more fruitful lines of work. Apart from this, the recapitulation of the achievements of the Leather Manufacturers' Research Association, notably in the control of heavy leather tanning, the use of the aqueous paraffin degreasing process and in the protection of both upholstery and bookbinding leather, are set forth in a form which should facilitate the educational work which is still the major problem in securing the full co-operation of the whole industry and the increased application of existing knowledge.

The dominant impression left by the Survey is, in fact, that the effort of the Research Association is distributed with reasonable judgment; but that the leather industry illustrates to the full the characteristic weakness of much of British industry at the present time. As Sir Henry Tizard insisted four years ago, the real need is to secure the increased and effective application of existing knowledge. In a considerable section of the leather industry, as so often elsewhere, that is hampered, especially in the small firm, by the absence of men with sufficient scientific and technical knowledge to appreciate the significance of new advances. The implementation of some of the recommendations of this report—as, for example, publicizing the best equipment and methods of flaying and preserving hides and skins, the further steps to be taken to apply existing knowledge to their improvement, and the application of mechanization and production engineering techniques to the processes of the industry—depends largely on the solution of this wider and much more general problem, to which the Department of Scientific and Industrial Research is known to be addressing itself.

ADVANCES IN ENZYMOLOGY

Advances in Enzymology and related Subjects of Biochemistry

Edited by F. F. Nord. Vol. 10. Pp. ix+533. (New York and London: Interscience Publishers, Inc., 1950.) 60*s*.

DR. T. ASTRUP contributes the first monograph out of a series of nine which constitutes this volume of "Advances in Enzymology". His article (with 328 references) consists largely of a review of recent work on the very important problems of blood-clotting and related processes. He considers briefly the early history of experimental work on the subject and proceeds to discuss the role of thrombokinase, which is a complex of a lipoid substance with a protein, and of calcium ions in the phenomenon of coagulation. The new observations that have arisen, concerning the conversion of prothrombin into thrombin, as a result of the widespread use of blood transfusions and dicoumarol medication and the various factors influencing thrombin formation are reviewed. The transformation of fibrinogen into fibrin in the clotting process, and the inhibition of coagulation by heparin, are fully discussed.

Dr. F. C. Happold surveys in an article of thirty pages the progress that has been made in the elucidation of the reactions of bacteria (chiefly *E. coli*) that lead to the conversion of tryptophane into indole. He discusses the early studies on indole formation, pointing out that the mechanism earlier formulated, which involved a fission of the indole nucleus of the tryptophane molecule and its subsequent reformation, could not be maintained. All recent work points to a rupture of the linkage $\equiv C_\alpha - C_\beta \equiv$ into $\equiv CH + \equiv CH$. The mechanism for this type of rupture is discussed, and the role of pyridoxal phosphate as a coenzyme in the reaction is considered. The various phenomena involved in the tryptophanase reaction—such as the action of inhibitors, the effects of indole and tryptophane derivatives, the importance of the integrity of the alanine moiety attached to the heterocyclic indole group, and the effects of the presence of phenylalanine or tyrosine in culture media—are all dealt with in considerable detail.

Drs. J. Roche and Nguyen-Van Thoai review in an interesting chapter of thirty-nine pages (149 references), written in French, the field of alkaline phosphatases. Both authors have contributed much to this important subject in recent years.

A timely article is that of Dr. W. Z. Hassid and M. Doudoroff on the synthesis of disaccharides with bacterial enzymes, a subject to which the authors

have made very valuable contributions. They discuss the adaptive enzyme, named sucrose phosphorylase, which controls the reversible reaction, sucrose + orthophosphate ⇌ glucose-1-phosphate + fructose, that occurs in such organisms as *Leuconostoc mesenteroides*, *Pseudomonas saccharophila* and *Pseudomonas putrefaciens*. They describe its preparation from *P. saccharophila* and its properties, such as its specificity with regard to the glucose portion of its substrates, its ability to cause disaccharide synthesis from glucose-1-phosphate and *l*-sorbose or *d*-xyloketose or *l*-araboketose or *l*-arabinose, and its inability to combine galactose-1-phosphate, or mannose-1-phosphate, or xylose-1-phosphate with fructose. The article contains much of value to all interested in the biological synthesis of disaccharides.

Aspects of streptomycin and other Streptomyces antibiotics are dealt with very competently in a twenty-page article by Drs. N. G. Brink and K. Folkers. They deal, in this review, with the salient features of the isolation of, and the researches that have been carried out on, some of the outstanding antibiotics (including chloromycetin, aureomycin and neomycin) produced by the Streptomyces group of organisms.

A most valuable article is that written (in German) by Drs. C. Martius and F. Lynen on the tricarboxylic acid cycle. They present certain historical aspects, that are not always appreciated by workers on this subject, and discuss a variety of topics bearing on this metabolic process. These include the occurrence of the citric acid cycle and the breakdown of acetate in yeast, the mechanism of the condensation reaction between the '2 carbon fragment' and oxaloacetic acid and the parts played by the '2 carbon fragment' in metabolism, the properties of aconitase, and the general significance in metabolism of oxalosuccinic acid, including its production from α-ketoglutaric acid. New observations not hitherto recorded in the literature are included in the article.

The next article, also written in German, is by Dr. T. Bersin, who has prepared a most comprehensive review of a hundred pages (391 references) on the chemistry and biochemistry of sulphur-containing compounds in plants. He discusses the metabolism of inorganic sulphur—dealing with substances such as sulphur, sulphates, polythionates and hydrogen sulphide, organic sulphur compounds (including sulphur-containing carbohydrates, amino-acids, peptides and proteins) and such substances as penicillin, biotin, thiamine and ergothionine. The article is of considerable importance to all workers in the field of sulphur metabolism.

Dr. W. G. Frankenburg presents, in an interesting and informative article of 116 pages (248 references), the second part of his report on the chemical changes taking place in the harvested tobacco leaf, the first part having appeared in 1946 in Vol. 6 (pp. 309–387) of "Advances in Enzymology". This extensive review is concerned with a description of the fermentation and ageing processes that are found in the harvested tobacco leaf, and with details of the chemical and biochemical changes occurring during these processes. Dr. Frankenburg comments on the fact that, although our present knowledge of the chemistry of tobacco fermentation is far from complete, certain conclusions with regard to the improvement of smoking qualities have been reached. Among these is the conclusion that a successful fermentation seems to serve, primarily, the purpose of removing substances which, in smoking, yield irritating and undesirable products. Thorough processing of the tobacco, including its fermentation, results in the disappearance of considerable amounts of proteins, amino-acids and alkaloids, but very much more detailed work is required before the fermentation and ageing processes can be described satisfactorily. The article is of considerable value to all interested in the possible pathological effects of heavy tobacco smoking as well as to the plant biochemist.

Dr. C. E. ZoBell deals finally with the assimilation of hydrocarbons by micro-organisms. This most interesting article describes how all kinds of hydrocarbons are attacked by micro-organisms—for example, *Pseudomonas æruginosa* that attacks *cyclo*hexane, *Bacterium hidium* that oxidizes kerosene and ethane, and *Actinomycetes oligocarbophilus* that assimilates aliphatic hydrocarbons, various bacilli that flourish on benzene, toluene and xylene, etc. Dr. ZoBell and his colleagues have isolated from marine sediments bacteria that oxidize naphthalene, anthracene and many other hydrocarbons. It is obvious that the study of the mechanisms present in micro-organisms that can attack such hydrocarbons as the ligroins, petroleums, lubricating oils, fuel oils, paraffin waxes, tars, etc., opens up a wide and most fascinating field in the realm of enzymology.

J. H. Quastel

SOME GEOLOGICAL PIONEERS

Giants of Geology

By Carroll Lane Fenton and Mildred Adams Fenton. Pp. xvi+334+16 plates. (Garden City, N.Y.: Doubleday and Co., Inc., 1952.) 3.50 dollars.

"GIANTS of Geology" is a second edition, revised and enlarged, of the authors' "The Story of the Great Geologists", first published in 1945, and later included in a series of pocket reprints issued for the American troops. Conservative British readers may perhaps find the style in which the book is written irritating. It is evidently intended for a wide public, and chapter headings such as "Those Skeptical Scots" and "Ex-Convict Professor" tend to belie the fact that the text is based on wide and well-informed reading of source material.

The 'giants' whose life and work are described include both European and American geologists. About one-third of the book deals with the former, and contains little that will be new to British readers. The later chapters are mainly concerned with the pioneers of American geology. They provide a most interesting account of the development of geology in North America. Evidently those who were responsible for opening up the continent in a geological sense had to be, and were, mighty tough, to use their own idiom. In the early and middle years of the nineteenth century much of the country was unexplored, and the geologists had all kinds of obstacles, physical and otherwise, to overcome, even to the extent of encounters with Red Indians. They often underwent great hardships; but their enthusiasm was such that in some cases, rather than give up, they used their own resources or earned money in whatever way was open to them, in order to keep going. In this book the reader will learn about the activities of T. W. Powell, one-armed veteran of the Civil War, who carried out an epic exploration of the Green and Colorado Rivers (which may recall to some British

readers the adventurous spirit of the late Prof. J. W. Gregory of Glasgow). Here, too, he can read about James Hall, whose palæontology of New York ran to thirteen volumes, for which the State of New York, in one year alone, appropriated 83,000 dollars. Yet Hall was no geological anchorite, but could "curse with the art of a river pilot", and always had a shot-gun at hand to emphasize an argument. The geological exploration of the 40th Parallel carried out by Clarence King was another great adventure. The story is told, also, of Sir William Logan, who founded the Geological Survey of Canada, though at an earlier date he was closely associated with the Geological Survey of Great Britain in the first systematic examination of the South Wales coalfield. Again, though there can be few British geologists who are unfamiliar with J. D. Dana's classic "System of Mineralogy", the seventh edition of which is now appearing, it is probably news to most that the first edition was published so long ago as 1837, and that its author took part, as a scientist, in a voyage around the world, before the second edition appeared in 1844.

Here, then, is a book which should provide pleasant leisure reading for geologists in any country; and for those who may be tempted to learn more about the achievements of these early workers, each chapter is provided with a bibliography. In the text the serious student of the history of geology will find occasional slips that need correction; but these need not detract from the enjoyment which the book will surely provide for most readers. Some, however, who are familiar with Raeburn's delightful portrait of James Hutton, will be at a loss to understand why this was not reproduced, instead of an imaginary and not very attractive drawing of Hutton, based, it is stated, partly on the Raeburn and partly on a draped bust.

X-RAY DIFFRACTION PHOTOGRAPHS

The Interpretation of X-Ray Diffraction Photographs

By Dr. N. F. M. Henry, Dr. H. Lipson and Dr. W. A. Wooster. Pp. ix+258. (London: Macmillan and Co., Ltd., 1951.) 42*s*. net.

THE authors state that the primary purpose of this book is to help students and research workers to understand the theory and practice of the interpretation of X-ray diffraction photographs, and there is no doubt at all that those embarking on the study of X-ray crystallography will find the book most helpful. The interpretation of photographs is by no means the whole of X-ray crystallography, but it is a very essential part of it, and on the whole the authors have covered their subject and its necessary preliminaries very well indeed. The treatment is generally simple (usually geometrical rather than analytical) and benefits greatly from the use of a profusion of carefully selected diagrams, many of them specially drawn for this book and wherever necessary drawn to scale so that the student may make measurements on them directly. One good feature is the use of the same substance in illustration of several techniques, so that their interconnexions become clear, and another is the provision of examples for the student to work, solutions being given in an appendix. Among many commendable matters of detail, one which deserves special mention is the full and clear discussion of the relationship between the hexagonal and rhombohedral systems, a topic which often presents difficulties to beginners, but which is too seldom presented to them in explicit detail.

On the debit side it has to be said that the treatment is uneven as between different parts of the book, that the co-ordination of different chapters is not always satisfactory and that some of the biggest practical difficulties likely to be encountered by beginners are not dealt with at all. The extent to which the last point can be regarded as valid criticism depends upon the scope expected of a book entitled "The Interpretation of X-ray Diffraction Photographs"; in most of the book the authors seem to take the view that it is not part of their task to teach the student or research worker to deduce from bad photographs how to get good ones, nor to give him guidance on what photographs to take. It is true that the procedure for correcting the setting of mis-set crystals is implicit in the full discussion on the study of orientation in single crystals in Chapter 8, but experience suggests that a simplified discussion at an earlier stage in the book (preferably with an example) would have been much more useful to the beginner. Apart from the difficulties of accurate setting, the first major problem which confronts the beginner who has to handle the products of organic chemistry rather than the robust and relatively well-crystallized specimens of mineralogy is likely to be how to determine the system to which his crystal belongs, and how to find the true unit cell with the least wastage of X-ray film (an important economic point). His crystals are perhaps fine needles and he has no difficulty in getting well-set needle-axis photographs; what can he deduce from them and what does he do next? A discussion of this and similar problems would have added greatly to the value of the book; as it is, the student will not get much guidance even on so important a matter as the determination of the β angle of a monoclinic crystal, no X-ray method for which appears to be given.

Descriptions and discussions are not always as precise as they should be, and a minor source of irritation is that concepts are sometimes used before they have been defined, and without a reference forward; on the other hand, the cross-references have not always been checked. Thus, on p. 46 it is stated that "it is desirable to use a crystal of thickness such that the absorption factor is nearly unity for the reasons discussed in 2.5.1", but, in fact, the absorption factor is not mentioned in 2.5.1 (that is, section 5.1 of Chapter 2), and, so far as I have been able to find, the reasons referred to (which are quite important) are not given anywhere in the book.

It is probably more important in a book of this kind to give references which students can find easily than to be meticulous about priority, and in any event first references to details of technique are particularly difficult to trace. Nevertheless, it is no bad thing to let students see that techniques which are older than they are can sometimes still be useful, and it is perhaps worth pointing out, taking two examples more or less at random, that the first references in the literature to collodion tubes to protect specimens (p. 170) and to focusing cameras (p. 174) are respectively at least seventeen and twelve years earlier than those given.

The criticisms made above should not obscure the fact that this is a valuable addition to the literature of X-ray crystallography. The book is well produced

and I have observed only one misprint and two or three minor errors of fact. The price is not unreasonable on current standards, particularly having regard to the wealth of illustrations.

E. G. Cox

OUR REMOTE PREDECESSORS

Prelude to History

A Study of Human Origins and Palæolithic Savagery. By Adrian Coates. Pp. xviii+289+3 plates. (London: Methuen and Co., Ltd., 1951.) 22*s.* 6*d* net.

THE attitude of prehistorians to their subject has changed considerably in the past thirty years. As a result, many of the classic treatises are now out of date. Much more has actually been discovered, and there is more evidence available to back up intelligent guesses as to the outlook of the remote folk of prehistory in respect to matters for which no actual relics could survive. It is still true to say that we can with safety go no further than the implements will take us as regards "our fossil-forerunners" of lower palæolithic times; but when we come to "our forerunners" of the upper palæolithic and mesolithic epochs we can legitimately fill in many gaps—we can clothe to some extent the dry bones of factual evidence with flesh and blood. Of course, this is still more the case with "our ancestors" of the neolithic and early metal ages.

From time to time it is very necessary and refreshing to stand back and take stock of what is known as a whole—a task for which the professional specialist often knows too much of details, sometimes nearly irrelevant, and as a result any general book written by him tends to lack balance. Such a survey is best undertaken by an intelligent and really knowledgeable amateur of the subject: one who has read widely but whose nose is not so close to the wall—perhaps himself adding brick to brick of knowledge—that he cannot see the proportions and scope of the edifice itself. The author will need a selective judgment, an eye for essentials, if his survey is to convey a correct impression. To my mind, such a book is to be found in "Prelude to History", and Adrian Coates is to be congratulated on having written it. The work is well illustrated and gives a very good picture of what is now known of human life and habits before neolithic times. An attempt, too, has been made to link up the various cultures with the type of folk who evolved them, and the small sketches of the various skull forms are not the least valuable part of the work.

After a short foreword by my colleague and former pupil, Dr. G. E. Daniel, there is a general introduction, and next the stage is set upon which the various cultures of western Europe will play their parts. This naturally involves some geological considerations, but these questions are dealt with in a simple manner. The problems of the evolution of man and early palæolithic times are next considered, and the way is then cleared for an account of late palæolithic cultures, the various racial groups concerned, and the wonderful art of this period. A chapter on the primitive mind and another on primitive society follow. Here, of course, the author passes more into the realm of the hypothetical. But there is much food for thought in this part of the book. Finally the author leaves the hunting economy and considers the relationship between the older food collectors and their food-producing successors.

As I have said, "Prelude to History" gives a very useful general picture of the subject and embodies the modern approach to the study of these remote peoples.

M. C. Burkitt

FIELD CROPS IN THE UNITED STATES

Field Crops

By Howard C. Rather and Prof. Carter M. Harrison. (McGraw-Hill Publications in the Agricultural Sciences.) Second edition. Pp. ix+446. (London: McGraw-Hill Publishing Co., Ltd., 1951.) 47*s.*

CROP husbandry is a large enough subject in Great Britain; in the United States, with a much longer list of cultivated crops and the additional complications arising out of soil erosion, farm crops or agronomy covers a formidable range. The second edition of this book by the late Prof. H. C. Rather and Prof. C. M. Harrison, of Michigan State College, brings up to date their account, originally published in 1942, of the essentials of crop husbandry in the United States. The book is addressed primarily to college students taking up the study of agronomy and those working in related fields who need to appreciate the broad principles of the subject. The material is presented in text-book form, each chapter being followed by a list of questions bearing closely on the subject-matter, and a set of problems requiring more thought and wider reading.

The subject is introduced by chapters dealing with soil conservation and management, including erosion control, fertilizers and rotation. This is followed by soil cultivation, and here the stress is laid on weed control. Several chapters are then devoted to the growth and management of legumes, forage crops and pastures, which depend fundamentally upon livestock, and this aspect of crop production is rightly given great prominence. To British readers who may be unfamiliar with United States agriculture, the relative importance of crops common to both countries such as alfalfa (lucerne), timothy grass, blue grass (*Poa pratensis*) and, in particular, white clover will be of interest. Of the last, the authors say that nearly all the white clover seed sown in the United States is used in lawn grass mixtures. It is interesting to note that no less than 2½ million acres in the United States are devoted to seed production of six leading legumes and grasses, and a valuable chapter is devoted to this subject.

The remainder of the book deals with the important cereal, root and industrial crops, including cotton, sugar crops and tobacco, a useful feature being a series of maps showing their distribution throughout the United States. The material is carefully selected, much of it from the extensive literature issued by the State colleges, and references are given to some of the more important publications.

The book gives an excellent view of a subject that is continually developing in mechanization, weed control and crop improvement. It does not overlook the impact of practical farm affairs and economic forces which are at least as important as technical advances. It is well illustrated and has an adequate index.

Psychology and the Industrial Worker

By E. G. Chambers. Pp. x+190. (Cambridge: At the University Press, 1951.) 10*s.* 6*d.* net.

OF the 119 references listed at the end of this book, fewer than a third concern work reported during the past decade. The investigators who receive the largest numbers of 'mentions' in the index of names are S. Wyatt, H. M. Vernon, E. Farmer, J. N. Langdon, T. Bedford, M. Culpin, May Smith, H. C. Weston, B. Muscio and the author himself. From these two facts alone, it is possible to draw the correct conclusion that the book is mainly about the pre-war work of the Industrial Health Research Board. As most of the original reports of the Board are nowadays difficult to obtain, and seem unlikely to be reprinted, Mr. Chambers has met a real need, and on this he is to be congratulated. It is particularly gratifying to have available a convenient summary of some of the early work of Dr. Wyatt, whose services to industrial psychology are insufficiently appreciated.

But as "an attempt to examine the principles underlying the work of the psychologist in the industrial field", the book is more than disappointing. Its scope is far too narrow, and its neglect of recent work far too great, for it to provide a satisfactory basis for any such examination. Indeed, it is difficult even to discern the principles the author claims to be scrutinizing. Moreover, when he moves away from the particular parts of the field of which he has first-hand knowledge, Mr. Chambers is apt to become embarrassingly naïve (as in his chapters on guidance, selection and training) or even inaccurate (as on p. 149, where he says, "tests . . . are the sole material of the factor analyst"). The value of the book is further diminished by the fact that it has been used for the expression of some of the author's political opinions. This is all a great pity, because mixed up with the chaff there is wheat, even in the least satisfactory chapters. A. RODGER

Organic Reactions

Vol. 6. Roger Adams (editor-in-chief). Pp. viii+517. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1951.) 64*s.* net.

THIS book is similar in style, arrangement and calibre to the previous volumes of this well-known and highly respected series. The ten chapter-headings (with authors' names in brackets) indicate the fields which are covered: Stobbe condensation (Johnson and Daub), preparation of 3 : 4-dihydro-*iso*quinolines and related compounds by the Bischler–Napieralsky reaction (Whaley and Govindachari), Pictet–Spengler synthesis of tetrahydro*iso*quinolines and related compounds (Whaley and Govindachari), synthesis of *iso*quinolines by the Pomeranz–Fritsch reaction (Gensler), Oppenauer oxidation (Djerassi), synthesis of phosphoric and phosphinic acids (Kosolapoff), halogen–metal interconversion reaction with organo-lithium compounds (Jones and Gilman), preparation of thiazoles (Wiley, England and Bahr), preparation of thiophenes and tetrahydrothiophenes (Wolf and Folkers), and reductions by lithium aluminium hydride (Brown).

Each chapter contains a wealth of practical detail, and the tabular surveys of applications are carefully compiled and complete. There is, however, a regrettable difference in the date to which the literature has been studied. This varies from the end of 1946, which really appears to be inexcusably remote, to January 1950. Some of the chapter headings suggest that it is time to abandon the use of authors' names as a trivial title for a reaction.

The increase in price of the volumes from 4 dollars (24*s.*) to 8 dollars (64*s.*) on ascending the series is noted with resignation. J. HONEYMAN

Oxidation-Reduction Potentials in Bacteriology and Biochemistry

By Dr. L. F. Hewitt. Sixth edition. Pp. viii+215. (Edinburgh: E. and S. Livingstone, Ltd., 1950.) 20*s.* net.

THIS new edition of a well-known book, formerly issued by the London County Council but now under the imprint of a regular publisher, follows similar lines to the previous ones, and has been considerably enlarged. Its usefulness to a large circle of biologists is shown by its continued sale during the past twenty years, and no doubt it will continue to appeal to biochemists and bacteriologists who find it convenient to have in one book the varied facts concerning oxidation and reduction in biological systems. It is possible that, now oxidation–reduction phenomena in biological systems have been more intensively studied and better understood, many will prefer to find their information in the more general text-books where oxidation–reduction reactions are treated as one example of many kinds. Nevertheless, this book remains a useful source of information on this aspect. In this edition the author has gone rather outside the field of oxidation–reduction, for example, in his discussions of enzyme inhibition, antibiotics and bacterial adaptation. Though no doubt there is scarcely any biological phenomenon which is not in some way connected with oxidation or reduction processes, it might have been better to limit the discussions to cases in which the connexion is not indirect. There is an extensive bibliography, mainly to work earlier than 1942.

Powder Metallurgy

(Selected Government Research Reports, Vol. 9: Issued by the Ministry of Supply: Published for the Technical Information and Documents Unit of the Department of Scientific and Industrial Research.) Pp. iv+159+31 plates. (London: H.M. Stationery Office, 1951.) 18*s.* net.

THIS volume consists of ten reports of powder metallurgical investigations carried out in British government laboratories and research stations, and was published in September last. The titles of the reports indicate their subjects and are as follows: No. 1, the surface energies of metals and alloys; No. 2, the examination of sintered metal components; No. 3, some properties of engineering iron powders; No. 4, production of iron powder by electrodeposition; No. 5, German sintered iron bearings; No. 6, trials of sintered iron driving-bands for 20-mm. Oerlikon ammunition; No. 7, sintered iron–copper compacts; No. 8, an aluminium alloy made by powder metallurgy; No. 9, notes on German developments in non-carbide powder metallurgy (1939–45); No. 10, the tensile strength of titanium at various temperatures.

Five of the reports, Nos. 3, 4, 7, 8 and 9, were published in 1947 in Special Report No. 38 of the Iron and Steel Institute. Of the others, three are of great interest and value, namely, Nos. 1, 2 and 10. It is useful to have the papers neatly bound in a single volume, but somewhat unfortunate that publication has been delayed so long.

THE EARTHQUAKE SERIES IN ST. KITTS–NEVIS, 1950–51

WITH NOTES ON SOUFRIÈRE ACTIVITY IN THE LESSER ANTILLES

By Dr. P. L. WILLMORE

Department of Geodesy and Geophysics, University of Cambridge

At about 18.15, local time, on December 27, 1950, the islands of St. Kitts and Nevis in the British West Indies were shaken by the first of a series of earthquakes which continued throughout January 1951. Minor renewals of activity occurred in March and in May, and occasional tremors have continued up to the time of writing. Public apprehension was sharpened by the memory of the recurrent crises in Montserrat during the years 1934–36, and by the fact that earthquake swarms have been among the preliminary symptoms of most of the major volcanic eruptions in the archipelago.

Early in January 1951 I was invited by the Colonial Office to investigate the development of the crisis, and to advise on any measures which could reduce the danger to the inhabitants. Preparations in Cambridge included the adaptation of a sensitive electromagnetic seismograph for operation in St. Kitts, and the construction of metal parts for nine small shock recorders. I arrived in St. Kitts by air with most of the equipment on February 5.

The assembly of the small shock recorders was completed in St. Kitts. The instrument consists essentially of a brass weight supported on beryllium–copper leaf springs, and free to oscillate horizontally with a period of about 0·5 sec. It registers on smoked paper wrapped around a drum which is driven along a fixed screw by a rod attached to the hour shaft of an alarm clock. The lever which carries the stylus provides a static magnification of about 5, which gives usable records for earthquake intensities between 2 and 6 degrees on the Modified Mercalli scale. A vane attached to the lever moves in an oil dashpot and provides approximately critical damping.

The electromagnetic seismograph was of a type which has been described previously[1]. It was operated in conjunction with a photographic drum recorder designed for daylight working, running at a speed of 46 mm./min. The instrument was capable of providing a velocity sensitivity of 500 cm./cm./sec. over the frequency range of 3–25 cycles/sec., but the microseismic disturbance was such that only about a thirtieth of this sensitivity could be used.

Observations began with a macroseismic survey of the effects of the earlier tremors. Although more than 150 shocks are known to have occurred during the first month of the crisis, it soon became evident that two shocks, on December 29 and 31 respectively, were outstandingly severe. The earlier shock was felt most strongly in Nevis and appears to have been responsible for most of the damage to stone buildings, so that the survey was restricted to the effects of this tremor. Intensities on the Modified Mercalli scale are entered on the accompanying map, together with the isoseismal corresponding to an intensity of about seven degrees. At Basseterre in St. Kitts the shock was felt with an intensity of about six degrees, and at Antigua, fifty miles away, of three or four degrees.

The isoseismal is convex towards the high-intensity side. As the complete line must be a closed curve surrounding the epicentre, this is evidently a local anomaly, probably arising from a tendency for buildings near the centre of Nevis to be on higher and rockier ground, and hence to have more solid foundations than the others. The distortion of the isoseismals prevents the focus from being located accurately; but it could scarcely have been anywhere near the centre of Nevis, and probably lay offshore to the west or south-west. It was noticed that the tops of damaged structures usually fell on the westward side of the foundations, which is consistent with the idea of an initial displacement from that direction. On comparing the intensities observed in Nevis with those in St. Kitts and Antigua, it would

In the upper part of the figure, the intensity of the movements in Nevis on December 29, 1950, is indicated by Roman numerals. The Arabic numerals show the positions of the epicentres of some of the tremors which occurred during March 1951. The lower part of the diagram shows the location of the shock recorders and the position of Nevis in relation to St. Kitts, Antigua and Montserrat

appear that the distance between the focus and the nearest point of Nevis must have exceeded ten miles.

By the third week of February, shock recorders had been established at St. Paul's, Mansion, Middle Island, Cayon and the Agricultural Department at Basseterre in St. Kitts, and at The Mount, St. James, St. Georges Gingerland and Bath in Nevis. During April, the recorders at Cayon and Middle Island were moved to Butlers and to a site near The Mount in Nevis. Owing to the low level of activity in recent months, most of the equipment has been allowed to stop working, and the information relating to recent shocks is derived entirely from the recorders at the Agricultural Department and The Mount.

Experience during the Montserrat crisis[3] had shown that the response of a short-period horizontal shock recorder to waves of given amplitude was only slightly affected by the bearing of the source. Epicentres were therefore located on the assumption that the reading of the shock recorder provided a sufficient measure of the intensity at the station and would decline steadily with increasing distance from the source.

The electromagnetic seismograph was operated in the Agricultural Department for a total period of 320 hours in April, and recorded eight tremors. Only one of these was detected by any shock recorder and this was centred about 140 km. from Basseterre. There is therefore no effective overlap of the kind which would enable the two methods of location to be compared directly.

Towards the end of March, a number of tremors occurred within two or three kilometres of Nevis Peak. In April, six of the eight tremors recorded by the electromagnetic instrument had P–S intervals in the range $2{\cdot}1 \pm 0{\cdot}2$ sec. Using plausible estimates for the rate of increase of the P–S interval with distance, an interval of 2·1 sec. would correspond to a range between 15 and 19 km. Circles of these radii have been drawn on the map and suggest that the focal region for the April tremors was starting to move away towards the north or west. By the time of the May series, there was insufficient equipment running to locate the epicentres accurately, but most of them appear to have lain in the bay south of Basseterre. Recent activity has included several shocks with P–S intervals exceeding 10 sec. The data are therefore consistent with movements starting at a considerable distance from land and probably inside the island arc, then rising to a point on the periphery and finally dispersing over a wider area. At no time was the activity centred near the volcano of St. Kitts, which is believed to have erupted in historical times. The temporary concentration near Nevis Peak was on a minor scale and was not accompanied by any significant increase in soufrière activity. The crisis therefore never reached a stage at which emergency measures (other than the sheltering of the occupants of damaged houses) appeared to be required.

The seismograms obtained recently by the two instruments at The Mount give an impression of the consistency of the small shock recorders. Under these ideal conditions, the two instruments usually agree to within 10–15 per cent; but geological irregularities may introduce larger differences when a single tremor is recorded by two separate stations equidistant from the focus. In spite of this difficulty it appears that amplitude measurements from a group of shock recorders provide the best method of locating foci at very short distances. The present instruments have generally proved adequate for the purpose and are extremely simple to construct and maintain.

After the apparatus had been installed on St. Kitts and Nevis, a rapid tour was made of the soufrières on the other islands of the arc. Most of these are situated in craters and valley bottoms, and consist of areas of decomposed rock pierced by irregularly shaped vents. These vents emit a mixture of steam and sulphur gases which, during quiet periods, usually have a temperature a little below that of boiling water. During periods of abnormal activity the temperature of the exhalations often rises, and the predominant sulphur constituent may change from hydrogen sulphide to sulphur dioxide.

The tendency for the temperature to become stabilized near boiling point is readily explained on the assumption that the soufrière is supplied by hot juvenile gases which bubble through meteoric water on their way to the surface. The change in gaseous constitution during active periods is presumed to occur because the original magmatic gases undergo reactions on their way to the surface, so that the end products depend on the temperature and velocity of the flow.

Previous observations on the islands which were visited have been limited to the analysis of the dry constituents of the gas emitted, and to the measurement of temperature and pressure in fumaroles. Pressures have been measured by burying funnels a few inches below the surface of the crumbling rock; but the results are probably as dependent on a very variable arrangement of leakage paths as on the conditions of the gas sources. The temperature, and the results of gas analyses, will only alter appreciably in response to large changes of underground emission. The determination of total energy flux would evidently yield a much better indication of total activity, but this requires simultaneous measurements of the temperature and rate of flow in the fumaroles and in any hot springs. The flow of gas could probably be measured by means of a Pitot tube, used in conjunction with a set of masking plates drilled with holes of standard size. The problem of measuring water flow is simplified by the fact that in many soufrières the outlets of the numerous small streams converge into a single channel, but underground seepage and the loss of heat from exposed surfaces introduce awkward corrections. Evidently the absolute value of the final estimate will be a very rough approximation, but under standardized conditions quite small departures from the mean output might be detected.

Soufrières were visited on Montserrat, Dominica, St. Vincent, St. Lucia and Grenada, in addition to those on St. Kitts and Nevis. Gas temperatures were measured and rough estimates of the energy flux were made in most cases; but as it is hoped that the experiments will shortly be repeated in a much more refined manner, it is proposed to defer publication of most of the results. The Boiling Lake region of Dominica was by far the most active area visited—with a thermal output in the vicinity of 10^7 calories/sec. A small eruption probably requires a thermal energy of the order of 10^{15} calories. This amount would accumulate within a few years if emission from the soufrières were to be prevented, so that the local belief that they are an effective 'safety valve' receives some quantitative support.

During the Nevis crisis, the difficulties experienced by earlier workers in this field have reappeared. As at Montserrat in 1936, the observer arrived with

improvised equipment, late in the course of the crisis. He had to work in ignorance of the earlier stages of activity and without any precise information of the normal condition of the islands. These difficulties can only be avoided by the establishment of a regular observing system. In view of the likelihood that further crises will occur within the next few years, the Colonial Office has asked for recommendations in this direction. As the centres of activity are known to oscillate along the whole length of the arc, it is clearly undesirable for attention to be concentrated on the most recently affected island. Earthquake epicentres must be located wherever they might occur, and it is proposed that a single sensitive seismograph should be maintained on each of the major British islands, and the records collected for interpretation at a central office. The small shock recorders would form part of a mobile reserve of equipment which would be sent to the centre of any concentration of activity. Operations would be under the control of a full-time, scientifically qualified observer, who would make regular tours of inspection during quiet periods. Quite apart from the value which these observations would acquire in time of crisis, it is to be expected that they would provide important scientific information on the structure of the arc and on processes which are continuing underground. These recommendations have been accepted in principle and the assembly of the equipment has begun.

In conclusion, I desire to express my appreciation for the hospitality and assistance which I received from the Governor of the Leeward Islands (His Excellency Kenneth Blackburne), from the Administrator of St. Kitts (His Honour H. Burrowes), and from the Warden of Nevis (the Hon. E. A. Evelyn). Further thanks are due to those residents of St. Kitts and Nevis who housed and operated the instruments, particularly to Mr. R. E. Kelsick and Mr. H. Hadden, who are continuing their services at the time of writing. Finally, I must express my gratitude to those people on many islands whose friendliness and hospitality did so much to enliven my stay in the Caribbean area.

[1] Willmore, P. L., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, **6**, 129 (1950).
[2] Powell, C. F., *Phil. Trans. Roy. Soc.*, A, **237**, 1 (1938).

FIBRES FOR PAPER-MAKING

THE scarcity and high cost of paper are matters of which everyone is painfully aware, even in a world of rising prices and shortages. They are, however, of special importance to the scientific worker because they affect the scientific publications on which he depends. Most learned and similar societies have been compelled within recent years to make considerable economies in their publication costs or to raise their subscriptions, or both; and although printing costs are one of the principal factors responsible, the paper question is also of great importance.

So far as paper in Great Britain is concerned, the price and availability of the fibrous raw materials used to make it are the controlling factors, so that the problem has both scientific and economic aspects. For these reasons the sixty-third general conference organized by the Technical Section of the British Paper and Board Makers' Association (Inc.), and held at Manson House, London, during March 27–28, should be of special interest to scientific workers of all denominations.

The subject of the conference was "Fibrous Materials for Papermaking—the Present Position and Future Possibilities", and the introductory paper dealing with the subject in a general way was by Sir Herbert Hutchinson, director-general of the Association. Sir Herbert's contribution was essentially factual, and it outlined clearly the problems that face the industry. Special emphasis was placed on the fact that, in recent years, of the world consumption of timber only about 8 per cent was in the form of wood pulp. Moreover, of the world consumption of wood pulp, only about 5 per cent is used in the United Kingdom, while in Canada alone 3 million tons of merchantable timber is destroyed by fire every year.

It is apparent that British needs are comparatively small in a very large world. Sir Herbert would not venture into the realms of prophecy, although he did go so far as to express the opinion that the materials used by the paper-making industry are not running out in a shrinking world. This general conclusion was, on the whole, supported by most of the other authors of papers and speakers.

It is as well, nevertheless, not to gloss over the potential seriousness of the situation. As one speaker pointed out, the present *per capita* consumption of paper and board ranges from about 400 lb. a year in the United States to only 2·4 in Asia; it is 116 in northern Europe. The United States figure is still rising, and, if it is even to be approached elsewhere in the world, a tremendous amount of raw material must be forthcoming; for example, a world-wide average increase of only 10 lb. *per capita* would require 20 million tons of raw materials.

The second and third papers were in many respects complementary, and they are conveniently considered together. The first, by L. G. S. Hebbs, provided a comprehensive approach to the problem of increasing cellulose supplies. In the other, I. G. Burns and J. Grant dealt principally with the potentialities in this connexion of esparto grass and straw, respectively.

The theme of Hebbs's paper, and of the speakers who supported it, was that considerable quantities of wood in one form or other are still available in various parts of the world. For example, there are the huge untouched forests of Central America and parts of Canada (where pulp production increased by 50 per cent between 1917 and 1950); there is the development of integrated forest industries on a sustained yield basis and advances in forestry management which could ensure supplies of wood in perpetuity; and there is also the prevention of the huge losses by fire. Much work, too, has been carried out on the utilization of types of wood (particularly hardwoods) hitherto believed to be unsuitable for pulping purposes, and also on the use of thinnings, toppings and other forms of what has, in the past, been regarded as sawmill waste and, as such, burned. The possibilities of hardwoods are of special interest. In general, their lower average fibre-length makes them less suitable for use alone in paper than are the softwoods. However, with a proportion of softwoods they serve an excellent purpose in printing papers or for board production. In Australia the eucalypts are already the source of a flourishing pulp and paper industry; and there are large stands of eucalypts in South America and of wallaba in British Guiana.

Some of these forests are not 'pure', in the sense that they consist of more than one species of tree. In the forests of British Guiana there are at least a hundred and twenty identified species; but fortunately not more than nine of these are present in such frequency that they have to be taken into account from the pulping point of view.

Hebbs's paper also dealt briefly with bagasse, bamboo, elephant grass, and other fibres which might be described as of local interest. The conclusion was reached that the contribution that such fibres can make is probably quite small, and insufficient to provide the large tonnage required to satisfy expanding world demand, although it would have undoubted value in many instances for local and specialized uses.

Burns and Grant emphasized the fact that esparto and straw have been closely associated together in Great Britain, because straw was used during the Second World War as an emergency papermaking material and was processed by those same mills which, before the War, made esparto papers. This was done merely because these mills alone had the necessary plant readily available in time of emergency, and it was therefore quite natural that they should use straw in the types of paper which they had formerly made from esparto.

Esparto is essentially a specialty fibre. Since its first use in 1861, it has established itself principally as a printing fibre by virtue of its capacity to produce paper having resilience to printing pressure, opacity, flatness, good register and, if suitably processed, freedom from 'fluffing' in the offset process of printing. It has attained this status as a result of long experience of manufacture in Great Britain and, indeed, it is not used to any appreciable extent elsewhere in the world.

The esparto supply position is fairly clear-cut. The grass is grown over wide though restricted areas in North Africa and to some extent in the south of Spain, and it seems unlikely for geographical reasons and because of the labour position that there will be any considerable increase in world supplies of paper from this source. Even assuming attractive market conditions, normal weather, absence of political unrest and extended exploitation of the Libyan fields, any increase in production would probably not amount to more than about 50,000 tons a year, which is equivalent to about 21,000 tons of pulp ready for papermaking. As the proportion of esparto in relationship to wood pulp imported into Great Britain has varied only between 17 and 25 per cent since 1913, and as the maximum annual import of esparto during this period was less than 350,000 tons, it is obvious that esparto cannot be counted on to increase markedly British supplies of cellulose. Nevertheless, it should continue to occupy the same privileged position as a specialty fibre that it has held for nearly a hundred years.

So far as Britain is concerned, the straw position is much more debatable. The reason for the association of straw with esparto grass has already been explained, but there are signs of the development of a natural differentiation since the War. Research along several different lines in various parts of the world has indicated plainly that the direct pressure digestion of straw with caustic soda (as used for esparto grass) is not the best method from the point of view of either quality or cost. It is too drastic, and not sufficiently selective, because in resolving the more resistant parts of the plant the true cellulose is overcooked. The resulting pulp is 'slimy', short-fibred, involves high chemical consumption and generally is not greatly liked by either the paper-maker or user. These were all drawbacks which could be accepted in war-time, when there was no alternative.

These unsatisfactory methods of manufacture are likely to be replaced by more selective forms of digestion. One continuous process already in practical operation involves a relatively light digestion with alkali followed by treatment with gaseous chlorine. The chlorinated constituents are then dissolved in alkali, and the resultant pulp, if bleached and screened, is satisfactory in colour and cleanliness. The character of the resulting pulp approaches a standard between ordinary wood pulp and straw made by the 'esparto process'. The yields, and chemical costs too, are better than those of the latter, but the process has the great disadvantage that the alkaline waste liquors cannot be recovered and must be discharged as effluent. This is objectionable on the grounds of economy and, of course, unless the mill is favourably situated, on the grounds also of river pollution.

Promising results have also been obtained by the use of neutral sodium sulphite or of sodium sulphide in the digestion liquors, the latter method following on the well-known kraft process for the manufacture of wood pulp. The general procedure is the same as with the standard soda cook; but improved yields, lower chemical consumption and a higher quality are obtained. The neutral sulphite process is particularly good where cheap supplies of that chemical are available.

Another and more recent process which is attracting a good deal of attention comprises the mechanical disintegration of the straw near the boiling point of water, without pressure, in dilute alkali, followed by screening to remove the coarse impurities, and bleaching by the type of three-stage bleaching process commonly used in Scandinavia and North America for bleaching wood pulp. This involves chlorination, an alkaline wash, and a hypochlorite bleaching stage. The results appear to be extremely promising. The high yields of 48 per cent of bleached pulp claimed are attributed to the fact that the pulp contains relatively high proportions of hemicelluloses, which the more drastic pressure-processes largely eliminate.

However, promising as these new digestion methods are, they can be only part of the story so far as Great Britain is concerned. The vital consideration is, of course, the availability of the raw straw. Unfortunately, various opinions, each carrying a measure of authority, differ widely; and although the statistics indicate that there should be ample supplies, in actual fact from time to time during the past few years there have been shortages, broken up, it is true, by periods of comparatively low price and plenty. In 1951 nearly seven million tons of straw were grown in Great Britain. After eliminating the 2½ million tons of oat straw used principally for feeding cattle and 250 thousand tons used for bedding, thatching, clamping potatoes, etc., there is a residue of some 4 million tons for 'other farm purposes' and paper-making and packaging. The difference of opinion arises as to the proportion of this which could be transferred from 'other farm uses' to paper-making. Many farmers maintain that return of the straw to the land is an essential feature of good husbandry for which there is no substitute. Others argue that synthetic fertilizers and other forms of

modern tillage produce as good results, and work in the United States has even indicated that straw left on the land may be detrimental to the subsequent growth of certain leguminous and forage crops. Several speakers expressed the belief that increased co-operation between the farming industry and the straw-pulping industry could make much more straw available for the latter, and so initiate a new and valuable national pulping industry.

The next paper, by H. R. Blanford, dealt with forestry in relation to paper and board, and was an excellent survey which confirmed in detail the general views set out above. J. Macdonald then dealt with British woodlands and their production, and as such his paper was also of great general interest. However, it led to the inevitable conclusions that in Britain the surplus land is needed too badly to grow food to enable the existing forests to be extended; and that the present forest-wood is either unsuitable for pulping, or else is needed for other more urgent purposes. No indigenous woodpulp industry therefore seems likely in Britain.

The final paper was an authoritative contribution from the Mead Corporation (United States) dealing with the removal of ink from waste paper. Considerable technical progress has been made in this direction; but again, so far as Great Britain is concerned, the matter hinges around the supplies of waste paper available, and this point was dealt with in a supplementary paper by S. F. Smith. Apart from imported waste paper, supplies in Britain of this material must necessarily be limited by the production of good paper, although the collection of waste paper continues to be of the greatest importance as an economy measure. It is interesting to note that the waste paper collected, expressed as a percentage of the total consumption of paper and board, has never been so high as in 1942, when it was 61 per cent. During 1949–51 it ranged from 28–31 per cent as against 20 per cent in 1939. Since the figure for 1951 corresponds only to about one million tons, it seems that there is still much room for improvement here. This point, and the danger of fluctuations between shortages and excesses, and means of evening them out, were emphasized by several speakers.

In the summing up which concluded the conference, common ground was shared by most speakers who held the view that, owing to sudden increases in demand (due to factors such as post-war development and rearmament, and accentuated by economic and distribution difficulties), the world in general, and Great Britain in particular, is at present experiencing a serious pulp shortage. The supplies of fibrous material existing in the world (especially of wood) should, however, certainly be sufficient to satisfy the immediate demand could they be made available. It is highly probable, moreover, that as education develops (particularly in Asia) pulp supplies can be stepped up to meet the increasing demand for paper, although temporary shortages may arise, just as trade cycles cause booms and slumps in other commodities. For all this the importance of vegetable fibres other than of wood should not be overlooked or even minimized, though quantitatively their possibilities may be less. Indeed, it seems certain that indigenous short-fibred plants such as straw, bagasse, bamboo, etc., will play a vital part in bridging the gap in various parts of the world, especially if the promise held out by new developments in pulping methods is realized.

JULIUS GRANT

EAST AND WEST IN SCIENCE

A SYMPOSIUM of the British Society for the History of Science was held on April 17 to discuss "Historical Scientific Contacts between East and West". This topic is attracting increasing attention from historians of science; it was an important theme of the Sixth International Congress of the History of Science held at Amsterdam in 1950; it is to be a prominent theme of the next year's conference at Jerusalem.

The present symposium was organized by Mr. F. H. C. Butler and included an important paper by Dr. Joseph Needham on Chinese mechanical sciences. The president of the Society, Dr. F. Sherwood Taylor, took the chair for the afternoon session, which was concerned especially with Arabic science. Chinese influences were discussed in the evening session, when Prof. J. R. Partington, a vice-president, took the chair.

The mysterious numbers such as 1, 3, 5, 8, 28, which so often play an important part in alchemy (as is evident in the recent work of Kraus), were discussed by Dr. H. E. Stapleton in his paper on "Possible Sources of the Numbers on which Jabirian Alchemy is Based". He showed that the numbers could have been derived by magic squares or by the areal measurements of Babylonian ziggurats, and hinted that possibly the magic square was itself in origin a formula concealing temple measurements; such an idea might account for the magical potency with which it was regarded.

A discussion by Dr. A. Armitage and others followed; but no conclusive evidence appeared to be available to settle the various interesting problems raised. Dr. Sherwood Taylor pointed out that Arabic efforts to express all elements in numbers may seem futile to us until we remember that modern physicists are doing very much the same thing.

Dr. D. M. Dunlop (Cambridge) then spoke on "John Mesue and his Work". John Mesue is little known to-day, but was extravagantly praised during the Renaissance when both his genuine work and a mysterious Latin corpus (associated with a mythical Mesue Junior) were ranked very highly. An investigation of the Arabic biographies shows that the real John Mesue (Yuḥannā b. Māsawaih) belonged to the early Baghdad phase of Arabic science in the early ninth century. His father had been employed in a subordinate capacity at Jundī-Sābūr; although unable to read, the clinical experience received there enabled him, after he had moved (*c.* 790) to Baghdad, to gain the confidence of the Caliph Harūn ar-Rashīd. Mesue's mother, a Slav, had been a slave-girl, but at Baghdad the young son John received a good medical education (under Jibrīl b. Bukhtyashū') and rapidly rose to fame and fortune, living in the suburb Dār ar-Rūm (Abode of the Greeks) and being considered one of the leaders of the Christian community in the city.

Many anecdotes are reported of his *majlis* (assembly), a combination of lecture-room and consulting-hour; but they reveal more of his wit than his methods—although it is evident that examination of urine and feeling the pulse were the standard clinical preliminaries. Freer perhaps from superstition than Galen's work, his "Axioms", written *c.* 830, emphasize common sense and moderation; he wrote a book (now lost) on the dissection of an ape which had been brought to the court in A.D. 835 by a visiting Abyssinian prince. His pupil, Ḥunain b. Isḥāq, from

Hirah, learnt Greek and became famous for his translations from the Greek into Syriac and Arabic. He was later Mesue's friend, and made translations of Galen specifically for him. Mesue, like many of his contemporaries, appreciated rather than understood Greek, for Syriac was at that time the language of science; he was an innovator inasmuch as he himself wrote in Arabic. The editor of 'Ali Tabarī's "Paradise of Wisdom" in 1928 described that work (*c.* 850) as "the oldest extant Arabic medical compendium"; the description should more properly be given to Mesue's "Medical Axioms". Certainly Mesue's is the oldest Arabic medical work known to the medieval West; hence he was sometimes called the "Evangelist of Medicine" by the Latins.

In a paper on "The Curve of Cultural Interchange between China and the West", Mr. D. Justin Schove referred to a graph published in the *Meteorological Magazine* (78, 14; 1949) and discussed the historical geography of early science in relation to the fluctuations of the trade routes. In the sixth century B.C., diffusion was taking place especially from the West to the East; Babylonian star observations had reached China at least by *c.* 525 B.C. (Chatley, Bezold); iron reached China by the same route in the same century and is specifically mentioned by 513 B.C. Shortly afterwards, other ideas such as the ox-drawn plough and coffins as in Egypt were adopted in China in the same way. Horse archers reached China before 300 B.C., and cavalry soon replaced chariotry in warfare all over Eurasia: in China *c.* 200 B.C.; in Britain not until the defeat of Boadicea. Pythagorean musical ratios and the statement of the 'theorem' ascribed to him reached China in the late third century B.C. Meanwhile the use of gold and the ideas of alchemy based on Babylonian chemistry had developed in China (as Dubs has shown) about the fourth century B.C.

The known development of the Silk Road took place from 200 B.C. to A.D. 300, and in the last two centuries Chinese science reached remarkably high developments—the inventions of paper and the seismograph being developed at this time.

About A.D. 300, unrest on the steppes seriously interfered with the Silk Road. China and the West began, especially from A.D. 400, to depend on India as intermediary for their cultural intercourse. The art of glass-making (the Chinese had depended on imports from the West) was introduced to the Chinese by the Indo Scythians in the fifth century, and in the sixth century the silkworm was concealed in a bamboo cane and introduced to the West, probably by Indian monks.

At this time there was a great inflow of Indian ideas to China. Religion and art were even more important than science, but from about 440 there occurred a Chinese scientific revival stimulated by fresh ideas received from India. After 650, science declined in India itself and also in China and the West; but the Chinese invention of paper received in Mesopotamia about 750 helped to stimulate the scientific renaissance which began at Baghdad shortly afterwards. Meanwhile, Chinese ideas of alchemy returning via the Silk Road had an important influence on medieval alchemy, which the Arabs began to develop at this time. In the thirteenth century cultural interchange began on a great scale, but the fruits were short-lived. In the eighteenth century Chinese influence on the arts of Europe was very considerable. Leibniz had suggested that Chinese missionaries should be sent to Europe, and Wolff was expelled from Halle for an address in praise of Confucius; but most of the scientific heritage of China had by then already reached Europe.

In the discussion which followed, Prof. E. G. R. Taylor referred to the evidence of flourishing trade both by land and sea shown in Ptolemy's "Geography" and expressed surprise that scientific interchange had not been even greater. Prof. Partington recalled how twenty years ago it had been imagined that Chinese alchemy was an offshoot of the Arabian. Dr. Stapleton pointed out that the arrival in China of ideas ascribed to Pythagoras was probably an introduction of ideas already developed in the Fertile Crescent where Pythagoras himself had gained his knowledge by travel.

Dr. J. Needham gave a foretaste of his forthcoming volumes on the history of Chinese science in his paper on the "Transmission of Ideas in the Mechanical Sciences between China and Europe". He showed the high attainments of the Chinese in mechanical engineering as early as the first century A.D., and convinced the audience with illustrations from original sources that the Chinese were superior to Europe or Islam in these fields from about the beginning of the Christian era until A.D. 1400.

Ideas which travelled from China to Europe included: the single-wheel barrow, sailing carriages, the camp-mill (mobile rotary quern), the square-pallet chain-pump (to Europe about 1540), rotary fans, deep drilling, efficient harness—(*a*) the breast strap (*c.* fourth century B.C. in China), and (*b*) the collar (*c.* A.D. 700 in China)—horizontal waterwheel, metallurgical blowing-engines (by A.D. 31 in China), tilt-hammers and water-driven trip-hammers, edge-runner mills (gunpowder mill), iron-chain suspension bridge, vertical-warp loom, drawloom, flyer in silk-winding, revolving bookcase, kite, and helicopter top (by fourth century A.D. in China).

The so-called gunpowder mill had been known in China since *c.* A.D. 300 and presumably spread west with gunpowder itself about the fourteenth century. Playing with the helicopter (or 'Chinese') top in 1796 led Cayley to his important studies which founded modern aerodynamics.

During the course of his address, Dr. Needham produced illustrations and other evidence showing the so-called 'Cardan' suspension in China, *c.* A.D. 180, and the 'south-pointing carriage' of about the same time, based on a workable system of gear-wheels involving a principle still used—it might be regarded as the first of all cybernetic machines. European harness was, in ancient and early medieval times, very inefficient, as a load greater than half a ton tended to suffocate the horse. The Chinese horse-load was 1½ tons; the breast strap had been developed about the fourth and certainly by the third century B.C. and had spread to Europe, perhaps about A.D. 500. The collar harness developed by *c.* 700 in China did not spread to Europe until *c.* 1200. Conversion of rotary to longitudinal motion was achieved in China long before the nineteenth century, indeed at least by A.D. 1313. One idea which had passed from Europe via Islam to China was the pot-chain pump (Saqiya). The Vitruvian vertical waterwheel had also passed from Europe to China.

Ideas developed apparently independently in both Europe and China included the waterwheel (see above), the hodometer and the paddlewheel boat. An illustration of *c.* A.D. 170 of a hodometer showed five passengers in a carriage on the top of which automatic figures beat out the distances on a drum

every *li*. With regard to the paddlewheel boat, we must now assume that the anonymous Byzantine "De Rebus Bellicis" of c. A.D. 370 was genuine but uninfluential. The idea also developed in China about the sixth century.

Water-raising machinery such as the swape (shaduf) with its origin in the Fertile Crescent had reached China by A.D. 170 and probably much earlier. Water-power developed in the West and China at just about the same time. The Pontus water-mill of 65 B.C. (Strabo) is followed within a century by water-power applied in China (A.D. 31) to blowing blasts of air for iron furnaces and forges with the use of complex machinery, so that considerable previous development has to be postulated.

In those cases where China borrowed from the West, the sources are sometimes explicit. Thus Ling Lun, the legendary minister of the Yellow Emperor, is said to have obtained the harmonic progression by travel to the West just as Pythagoras is said to have travelled in Asia. The origin of both Greek and Chinese acoustics must be Babylonian. Likewise the seventh century horizontal windmills of the windy region of Seistan (East Persia) were specifically suggested as models for China by Yehlu Chhu-Tshai in the Mongol period. Some Central Asian prayer wheels used wind power so cleverly as to resemble cup-anemometers.

Really new ideas which reached China through the Jesuits in the seventeenth and eighteenth centuries were few. The Chinese accepted from them the screw, the crankshaft, the cylinder-pump proper and cable ploughing. Gearing, cranes, the crank, the continuous chain excavator, etc., were unnecessary, as the Chinese already had them in use. The Chinese rejected some devices, such as the Vitruvian drum-treadmill (their pedals made it unnecessary), the Archimedean screw (though this was used for mine-drainage in Japan), the vertical windmill and the flume-swape.

In the discussion which followed, several speakers expressed the hope that the illustrations and Dr. Needham's discoveries would soon be available in print.

OBITUARIES

Dr. Bernard Lyot

The world of science, and French astronomy in particular, has suffered a severe loss in the sudden death, at the comparatively early age of fifty-four, of Dr. Bernard Lyot, one of the most brilliant observational astronomers of this century.

Lyot's early work in the 1920's consisted of measurement of polarization in the light of the moon and planets, and started characteristically enough with the construction of a new sensitive polarimeter. With this he also examined a considerable number of terrestrial substances, and showed that the moon's surface behaves as though covered with a layer of volcanic ash or dust. He discovered a fairly close resemblance between the polarization from Mercury, Mars and the moon, he found that Mercury could have at most a very tenuous atmosphere, showed that polarization from Mars was sometimes affected by haze or dust, and discovered irregularities of polarization from the Martian south polar cap, which he attributed to the frequent formation of clouds. His examination of the planet Venus, however, revealed a quite distinct behaviour, apparently due to the reflexion of sunlight from a cloud layer composed of droplets of refractive index near that of water, with diameters about 2 μ. Lyot also studied the polarization of light from Jupiter and Saturn, including Saturn's rings, finding a number of small effects still not fully explained.

In 1931 Lyot announced to an astonished and somewhat incredulous astronomical world that he had successfully observed the solar corona in full daylight. This feat had been attempted often enough in earlier years, sometimes by the most eminent observers, but had by then become to be generally regarded as impossible. Lyot had nevertheless succeeded, by inventing a new form of telescope in which all sources of scattered or false light were rigorously suppressed, and by using it in the best weather on the Pic du Midi (altitude 2,870 m.), up which he himself carried much of the equipment, on skis. Two years later he had made a polarizing filter of the type now known by his name, permitting (in contrast with the spectroheliograph) simultaneous photography over a field as big as the solar disk, in a spectrum band of the order of 1 A. wide. With this and with spectrographic equipment he worked on the Pic du Midi during the 1930's, following a very active programme of observation of the corona and the prominences, adding greatly to our knowledge of both. He measured the changes of surface brightness in the corona from day to day, particularly in the green and red emission lines, explored its spectrum thoroughly, adding five new lines and classifying the whole emission spectrum (its origin then still unknown) into groups of lines with common characteristics. He showed that the lines are wide and that their width increases with wave-length, and he demonstrated that the corona rotates at least approximately with the rest of the sun. He also studied prominence spectra, measuring the polarization in the continuous spectrum and in the lines $H\alpha$ and D_3, and produced some of the first cinematograph films showing prominence movements, films which are still unsurpassed in their fineness of definition.

Lyot's work relied on the production of flawless optical surfaces; he therefore invented new and sensitive methods of examining by phase contrast minute irregularities in the polish of a lens surface, and of discovering small inhomogeneities in large glass disks. Among his later achievements, he designed a large $f/1$ spectrograph for studying the light of the night sky; he attempted to detect a lunar atmosphere and showed that there is none with a density greater than 10^{-9} of the earth's atmosphere; he devised and used a simple but sensitive polarimeter for examining minor planets; his photographs of Mars and other planets are among the best yet obtained. Within the past two years he had published a method by which he had successfully observed the corona at sea-level. His last work consisted of spectroscopic observations of the corona at the total solar eclipse of February 25 of this year, and it was while travelling in Egypt shortly after this that a recurrence of heart trouble led to his death.

A man of charming modesty, Lyot had during the past twenty years built up a well-deserved international reputation for the originality and elegance of his methods, and for his powers as an observer. Looking back over his career, one is impressed not

merely by his inventiveness, but also by his independence of fashions in astronomical thought, by the admirable conservatism he always showed in interpreting his observations, and by the high quality of everything he did. In an epoch during which astronomy has become dominated by huge telescopes, he managed to make contributions of the finest and most significant character by his mastery of the ideas of classical optics, using only small telescopes and comparatively simple apparatus.

Lyot was awarded the Gold Medal of the Royal Astronomical Society in 1939, and the Bruce Medal of the Astronomical Society of the Pacific in 1947. He is survived by a widow and two sons.

R. O. REDMAN

Dr. J. F. Cameron

JOHN FORBES CAMERON, Vice-Chancellor of the University of Cambridge during 1933–35 and Master of Gonville and Caius College during 1928–48, died on March 21 at the age of seventy-eight. He was educated at Perth Academy and the University of Edinburgh before going up to Caius in 1895. In the Mathematical Tripos of 1898 he was Second Wrangler, bracketed with the late Sir James Jeans; and in 1900 he was awarded a Smith's Prize.

Finding that his interests and tastes lay in teaching and administration rather than in original work in mathematics, Cameron devoted his great abilities to these aspects of College and University life, with remarkable success. He had been elected a Fellow of his College in 1899, and in 1900 a lecturer in mathematics. In 1909 he became a tutor and, on his return from important posts in the Ministries of Munitions and Labour during the First World War, senior tutor. Two years later, in 1921, he was appointed bursar. On the death of Sir Hugh Anderson he was elected to succeed him as Master, in which office he governed his College for twenty years; for when, in 1943, he reached the normal retiring age, the College extended his tenure to the maximum permitted by the statutes—to 1948, in which year he reached the age of seventy-five.

Cameron's services to the University of Cambridge were manifold and distinguished. Immediately following his graduation he took a lively interest in the small but growing Department of Engineering, and he played an active part in the development of engineering in the University, being chairman of the Faculty Board for some years. He was elected to the Council of the Senate in 1924 and continued to serve on it for many years. He served also on the Financial Board and on the General Board of the Faculties. He was chairman of the Buildings Syndicate and, for twenty years, chairman of the University Press Syndicate. Cameron also took an active part in civic affairs. He was a town councillor for some years and he was chairman of the Cambridge Gas Company. In College, in the University, and in the town, Cameron's advice and help were often sought and always freely given. His mind was powerful and clear, his approach to problems of any kind was objective, and his judgment sound; and his sincerity and fairness were beyond question. When he retired in 1948 the University paid him the rare honour of conferring upon him an honorary degree of LL.D.; the Orator saluted him as *virum ingeniosum, sagacem, strenuum, amicum firmum et constantem*—a concise and apt description.

He married Miss Elfrida Sturge, daughter of John Edmond Sturge, of Birmingham and Montserrat, who survives him with one son and one daughter. A younger son died as a prisoner of war after being captured in France.

J. CHADWICK

Dr. R. W. Dodgson, O.B.E.

BORN in 1870 in Wigton, Cumberland, of Quaker parentage, Robert William Dodgson went to Owens College, Manchester, and thence in 1890 entered St. Mary's Hospital, Paddington, as a senior scholar in natural science. There he became assistant pathologist and showed outstanding ability as a teacher as well as in his other duties, his time at St. Mary's being rounded-off by a gold medal award with his M.D.(London) in 1898.

Dodgson's subsequent career falls into two periods, the first of which was mostly spent abroad. In 1900 he went to South Africa to inquire into the results of anti-typhoid inoculation of British troops serving there. This War Office appointment was followed by the directorship of the Government Research Laboratory at Cape Town under the Plague Administration, and in 1902 he became director of the Pasteur Institute of Rhodesia at Bulawayo. Two years later he returned to Britain and remained in private work until 1911. He then joined Sir Almroth Wright in an investigation of epidemic pneumonia among employees in the gold mines of the Witwatersrand, but in 1913 he left South Africa after a somewhat severe illness. Dodgson visited laboratories in France and Germany on his way home, and reached England just before the outbreak of the First World War.

The second period began in 1915 with an appointment under the Ministry of Agriculture and Fisheries to devise a method of freeing mussels from dangerous pollution. Dodgson's approach to this problem was through a comprehensive study of the physiology of the mussel, coupled with bacteriological investigation. A brilliant piece of research was the result, and his solution was applied on a commercial scale at Conway in 1916. Described in his report on mussel purification (1928), it will long be associated with Dodgson's name. The method he devised depends on the natural functioning of the shellfish in large tanks of sea water free from the irritating effects of sterilizing agents. The advantages of this principle have now been recognized in the United States, where for many years the exposure of oysters to an initial dose of active chlorine in sea water had been the practice for the purpose of purification. Later, Dodgson was appointed director of the Ministry's Shellfish Services. His study of shellfish problems as a whole led to comprehensive recommendations for compulsory treatment of all molluscs destined for human consumption in Great Britain. Although fulfilment of his ideal has not become practicable, his method of purification has been applied at some other shellfish centres in Britain and abroad. When a chance occurrence directed his attention to the possibility of using mussel purification installations for oyster culture during the off-season, he initiated a series of experiments which have yielded results of much value.

Before his retirement in 1937, which was followed by two years of service as a consultant in shellfish matters, Dodgson's services were recognized by the award of the O.B.E. He died on March 4 at his home in Conway, a bachelor, after a gradual decline in health.

Dodgson was endowed with sound judgment, singleness of purpose and a capacity for mastering details as well as the broad aspects of the matters which required his attention. H. P. Sherwood

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Dr. Poul Jespersen

The death of Dr. Poul Jespersen, on December 20, 1951, has removed from the ranks of marine biologists one who shared with Dr. Johs. Schmidt in the pioneer investigations on the life-history of the eel. Born on March 18, 1891, at Naesbyhoved near Odense, Jespersen was a naturalist from his boyhood days. While still a student at the University of Copenhagen, he sailed in 1913 on the schooner *Margrethe* to search for the larvæ of the eel in the Sargasso Sea. Afterwards, he was to take part in many oceanographic voyages, including the two-year cruise of *Dana II* to the Atlantic and the Pacific, and her world circumnavigation during 1928–30. Jespersen published many works on the life-histories of fishes and the importance of plankton as their food; he was also a copepod systematist. He succeeded Ove Paulsen as director of the plankton laboratory of the Danish Commission for Fisheries Research.

His special hobby since youth had been the study of birds, on which he published a number of papers, and in 1941 he became president of the Danish Ornithological Society. Just before his death, Jespersen had been appointed Secretary-General of the International Council for the Exploration of the Sea, and his presence will be missed by many friends at the Council's meetings. His wife and daughter survive him. F. S. Russell

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We regret to announce the following deaths:

Dr. Maria Montessori, the well-known educationist, on May 6, aged eighty-one.

Mr. James L. Peters, of the Museum of Comparative Zoology, Cambridge, Mass., known for his "Check List of Birds of the World", aged sixty-two.

NEWS and VIEWS

Vice-Chancellorship of the University of Birmingham: Sir Raymond Priestley

Sir Raymond Priestley retires on September 30 from the vice-chancellorship of the University of Birmingham, which he has held since 1938. His training as a geologist, his work in the Antarctic with the Shackleton and Scott expeditions, his long service as secretary of the Board of Research Studies at Cambridge and his period as vice-chancellor in Melbourne had given him wide experience of science and its organization, and so it was natural that the Faculty of Science in Birmingham should have skilful and sympathetic support from him; but the other Faculties have had it no less. Dr. Priestley, as he then was, set up his office in the old buildings in the centre of Birmingham, and it was his ambition to take the Faculties of Arts and Law from these buildings to join the rest of the University at Edgbaston. War and scarcities have prevented this; but many of his other ambitions have been fulfilled. The University has not only doubled its size: its internal government has become more democratic, new departments have been founded (genetics and electron physics are examples on the science side), and new links, such as the Shakespeare Institute at Stratford-on-Avon and the Department of Engineering Production, have been made with the cultural and industrial life of the Midlands.

Sir Raymond has done much for individuals and non-academic organizations in the University; he has always kept in personal touch with students and has been rewarded by enterprising and conscientious work by the officers of the Guild of Undergraduates in successive years. Popular with all the staff, he has shown particular interest in the lower grades and has been a staunch champion of their interests. His educational work has by no means been confined to his own University; he took a large part, for example, in the founding of the University College of the West Indies, and visits to it have been his chief relaxation in recent years. At the request of the University Council, Sir Raymond has remained in office beyond the normal age of retirement, and there will be general regret that he feels unable to continue still longer. He has been, by general consent, one of the outstanding vice-chancellors of his time.

Chemistry at University College, London: Prof. H. Terrey

Many friends and students of Mr. Henry Terrey, reader in chemistry at University College, London, since 1937, will have heard with pleasure of his elevation to a chair at that College as from January 1, 1952. He graduated B.Sc. in 1912 and in the same year was appointed student demonstrator in the Chemistry Department, where he has maintained an unbroken service, except for a short period in 1914. As well as having responsibility there for many years for most of the teaching of inorganic chemistry to senior students, he is also lecturer in the chemistry of painters' materials in the Bartlett School of Architecture and has been lecturer in dental metallurgy in University College Hospital Dental School. During the First World War he combined academic duties with research work for the Admiralty. Of researches later carried out with his students the first was an early example of the use of radioactive indicators, in determinations of the hydration of salts. Various X-ray spectrometric studies have been made, for example, of alloys, of silver subfluoride, of indium dichloride and of the coagulation of gold sols. In an examination of the platinoplatinichloride electrode a new and very constant type of chlorine electrode was evolved. Investigations in the chemistry of scandium, samarium and germanium are included among other widely spread work. Interest in history is fruitfully evinced in a paper on Edward Turner, the first professor of chemistry at University College. Prof. Terrey served on the Council of the Chemical Society during 1928–31. He is chairman of the Board of Examiners for the Internal B.Sc. in chemistry of the University of London, and chairman of a sub-committee on crystallography drawn from the Boards of Chemistry and Physics of the University.

Mathematics at University College, London : Prof. W. R. Dean

THE election has been announced of Mr. W. R. Dean to the Goldsmid chair of mathematics in University College, London, in succession to Prof. H. S. W. Massey, who vacated the post on taking up the Quain chair of physics in University College (see *Nature*, 165, 793; 1950). Educated at Christ's Hospital, Mr. Dean entered Trinity College, Cambridge, as a scholar in 1919 and was elected to a fellowship four years later. Since 1929 he has been College lecturer in mathematics at Trinity and also lecturer in the University. Before these appointments he had been an instructor in mathematics at the Royal Naval College, Greenwich, during 1922–23 and assistant professor of mathematics at the Imperial College of Science and Technology, London, during 1924–29. He served in the First World War as a lieutenant in the Royal Fusiliers, and during 1940–45 was a senior experimental officer in the Ministry of Supply. Mr. Dean has written a number of papers on elasticity and the motion of viscous fluids; his work was recognized by the award of an Adams Prize by the University of Cambridge in 1951.

Royal Society of Edinburgh : Awards

THE Council of the Royal Society of Edinburgh has awarded the Keith Prize for the period 1949–51 to Prof. Alastair Graham, Department of Zoology, Birkbeck College, University of London, for his paper on the molluscan stomach published in the Society's *Transactions* during the period of the award and for earlier contributions to molluscan morphology in the *Transactions* and *Proceedings* of the Society; and the Neill Prize for the period 1949–51 to Dr. J. Russell Greig, director of the Moredun Institute, Animal Diseases Research Association, Edinburgh, in recognition of his valuable contributions to the knowledge of methods of control of the diseases of domestic animals.

Royal Meteorological Society : Awards

THE Royal Meteorological Society has announced the following awards: Buchan Prize, founded in memory of Alexander Buchan, secretary of the Scottish Meteorological Society during 1861–1907, for the period 1947–51 to Dr. G. D. Robinson, for his outstanding contributions to the study of atmospheric radiation and other research; Hugh Robert Mill Medal and Prize for 1952, awarded in memory of Hugh Robert Mill, director of the British Rainfall Organization during 1901–19, to Dr. J. Glasspoole, for his outstanding contributions to the scientific treatment of the rainfall data of the British Isles.

Royal Institution

THE annual meeting of the members of the Royal Institution was held on May 1, with Lord Brabazon, president, in the chair. The following officers were elected: *President*, Lord Brabazon of Tara; *Secretary*, Prof. A. O. Rankine; *Treasurer*, Prof. G. I. Finch; *Managers*, Mr. E. R. Davies, Mr. P. Evans, Mr. H. S. Gibson, Mrs. H. K. Hawkes, Captain H. L. Hitchins, Mr. A. J. Hughes, Mr. L. B. W. Jolley, Dr. L. A. Jordan, Dr. J. Lawrie, Mr. A. J. Philpot, Mr. S. Robson, Dr. J. H. Schulman, Mr. P. H. Schwarzschild, Mr. K. E. Shelley, Mr. F. Wakeham; *Visitors*, Mr. F. G. Brown, Mr. W. Burrells, Dr. H. K. Cameron, Mr. A. D. R. Caroe, Mr. P. H. Carpenter, Mr. R. Cory, Mr. J. Home Dickson, Miss M. M. Grimes, Mr. M. M. Melinsky, Dr. E. H. Rayner, Dr. A. J. B. Robertson, Mr. W. E. Schall, Dr. L. Simons, Dr. P. C. Spensley, Dr. H. Stuart.

Astronomy in England during the Fourteenth Century

DR. DEREK PRICE has recently written two articles (*Times Lit. Supp.*, February 29 and March 7) in which he describes some very interesting facts brought to light by a recent examination of a manuscript entitled "The Equatorie of the Planetis" in the Perne Library, Peterhouse, Cambridge. This was written in 1392, and if, as is now thought probable, it is a hitherto unknown work of Chaucer, the manuscript is of great importance as it would provide for the first time an example of Chaucer's handwriting and also an uncorrupted specimen of his language and spelling. Various lines of evidence suggest that Chaucer was the author and not Simon Bredon, to whom it was once attributed, as it is now known that the latter died on or before 1372, the date when his will was proved. Probably the strongest evidence for the authorship is found in a note adjacent to a table for the conversion of years to solar days. This could not be seen completely until the volume had been freed from its nineteenth-century binding, and photographs of the note mentioning Chaucer by name have been reproduced in Dr. Price's article. Although it is admitted that this note could refer to some unknown planetary section of Chaucer's "Treatise on the Astrolabe", it is considered that this is less likely than the view that Chaucer was the author. If, however, the note does refer to the "Astrolabe", then only a very close collaborator could have known of its existence. The "Equatorie" appears to be a free adaptation from an Arabic or Persian source, presumably through a Latin translation. This is known from some of the technical terms that are used and also from the opening of the text, which is in typically Arabic style. The text contains a description of an instrument for finding the positions of the planets, and there are tables for determining the nodes of the moon, which are employed in the calculation of eclipses. The constructions of the instrument described are all based on the planetary theory contained in Ptolemy's "Almagest", and a very clear account is given of the technical terms and the method of using the astronomical tables which are found among medieval manuscripts.

Meteorological Office : Report for 1950

THE annual report of the director of the Meteorological Office for the year April 1, 1950–March 31, 1951 (M.O. 553; pp. 54; London: H.M.S.O., 1951; 1*s.* 6*d.* net) shows that major features in the work of the Office during the year were the provision of more specialized weather forecasts and the increase in the amount of research work in progress. The replacement in the B.B.C. Home Service from November 19, 1950, of the general land-area forecasts by regional forecasts supplied to B.B.C. regional headquarters by selected meteorological offices was an example of the former feature. The regional forecasts are more detailed and take better account of local needs, especially as regards agricultural purposes. With the development of jet aircraft, the amount of flying at heights above 40,000 ft. continued to increase, and the research in progress for several years on the measurement and forecasting of wind speed and turbulence at those heights was intensified. The basis of successful

weather forecasting is an accurate prediction of changes in the field of atmospheric pressure in the upper air as well as in the strength and movements of the familiar depressions and anticyclones at ground-level. It is interesting to see that trials of methods of numerical calculation of these changes were begun in the Forecast Research Division. On the physical and instrumental sides, the work in progress included research into the visibility of the ground from aircraft flying in fog or haze and, with the aid of radar and direct observation from aircraft of the Meteorological Research Flight, into the formation of rain and other aspects of cloud physics. The director of the Office, Sir Nelson Johnson, presided over the final conference of directors of the International Meteorological Organization, which opened in Paris on March 15, 1951, in his capacity as president of the Organization. He was elected president of the World Meteorological Organization, the first Congress of which was held in Paris last March.

Linen Industry Research Association: Report for 1951

The report of the council of the Linen Industry Research Association for the year ended September 30, 1951 (pp. 20; from the Association, Lambeg, Co. Antrim; 1951), records a membership of 289, compared with 281 at the end of the previous year, but the Association failed by a small margin to reach the trade subscription of £32,000 required to earn the maximum government grants. These have been fixed for the next quinquennium just short of the maximum of £22,000 and £13,000 from the Department of Scientific and Industrial Research and the Government of Northern Ireland, respectively. Much of the time of the staff continues to be occupied in the solution of day-to-day problems, and surveys of factories still form an important part of weaving research. Work on loom motions has borne fruit in a new design of universal shedding motion and a special form of picking shoe. Scutching trials have shown that the Van Hauwaert automatic spreader can be used with a turbine scutching machine fitted with the modified roller breaker, and further trials have confirmed that the design of the Linra modified roller breaker is satisfactory and that the equipment is ready for factory trials. A new precision type of stub remover has been designed and patented for improving the quality of yarns by removing the gross faults, such as spinner's piecings and flyovers, during high-speed winding, and the equipment is now being developed for commercial application. Work is also being carried out to improve the sizing of spun rayon yarns by adding to the tape-sizing machine an apparatus for wet-splitting and brushing the yarn, as well as to improve the production of level and well-penetrated dyeings on linen and rayon fabrics; in addition, promising results have been obtained in work on rot-proofing linen goods.

Parliamentary and Scientific Committee: Report for 1951

The annual report for 1951 of the Parliamentary and Scientific Committee (pp. 20; from the Committee, 31 Palace Street, London, S.W.1; 1952) contains the customary particulars of officers, subscribing membership and reports of the annual general meeting and annual luncheon on January 30, 1951, with a list of addresses and discussions arranged during the year. The discussions have included the progress and development of atomic energy in Great Britain, the work and future plans of the National Research Development Corporation, the future development of higher technological education, the contribution of science and technology to overcoming shortages of essential raw materials, the assistance given by the Economic Co-operation Assistance Mission to the United Kingdom in the scientific and technological field, the organization, work and plans of the Meteorological Office, and agricultural research, with special reference to cows and insects. Following a discussion in May on the application of science and technology, a sub-committee was set up to review this question and to advise what more could usefully be done to ensure the better application of science and technology in the British Colonies. Although no further reports have been issued during the past year on scientific man-power or fuel efficiency, both subjects have received attention from the Committee, and questions on various aspects of them have been asked or debated in Parliament during the year.

Recent Work of the Social Survey

A list of subjects investigated by the Social Survey Division of the Central Office of Information, during the past two years 1950–52, which was supplied by the Financial Secretary to the Treasury in reply to a question in the House of Commons on March 11 and printed in *Hansard* for that date, includes three investigations commissioned by the Department of Scientific and Industrial Research. One, on sound in dwellings, is an investigation, under actual daily living conditions, of the extent to which a new type of party wall reduced the amount of noise heard in local-authority dwellings. The second is a pilot study of the present distribution of science graduates made with the view of showing whether the Scientific Civil Service is recruiting its necessary share of the better graduates, and obtaining the reasons for not entering the Civil Service. The third is a pilot study to measure the flow of scientific information to industry, with the view of improving the work of the Technical Information Service of the Department. Also of some scientific interest are the investigations made for the Ministry of Labour into the employment of elderly workers, for the Ministry of Health on the nutritional level of children under the age of five years and on new problems in diphtheria immunization, and the statistical studies for the Registrar-General's Office designed to show the incidence of ill-health and injuries as well as the use made of the national medical service.

Professional Engineers Appointments Bureau: Activities during 1951

The Professional Engineers Appointments Bureau, 9 Victoria Street, Westminster, London, S.W.1, an organization which exists mainly for the placing of members of the Institutions of Civil, Mechanical and Electrical Engineers in suitable positions of employment, has recently reviewed its activities during 1951. The total of vacancies notified by employers was 1,070, of which 314 were for civil, 503 for mechanical and 253 for electrical engineers; overseas vacancies were approximately 30 per cent of these figures, and were in the main for the Middle East, West and East Africa, India and Pakistan. The Bureau made 7,276 nominations, of which 2,050 were civil, 3,444 mechanical and 1,782 electrical. Compared with 1,947 in 1950 and 1,981 in 1949, enrolments at the end of the year totalled 1,679, of which 385 were civil, 766 mechanical and 528 electrical engineers. This decrease

in numbers may be accounted for by the general shortage of qualified engineers and also by the fact that housing difficulties, etc., are a deterrent to those wishing to change their jobs. More than 10 per cent of the engineers placed in positions were more than fifty years old, and the Bureau now recommends persons without consideration of age unless the prospective employer specifies any conditions of age. The Bureau is desirous that an employer should make a personal review of its register so that a detailed discussion can be made of the suitability of a candidate for a particular situation. During the year more placings were made than previously, and a record total for appointment fees was achieved. However, owing to rising costs the expenses of running the Bureau were not covered by income, and liabilities could only be met by generous donations from industry, which totalled £2,563, as compared with £1,041 in 1950.

Multi-sensory Aids for Teaching Mathematics

For some years the mathematical staff of the Gateway School for Boys, Leicester, have shown much energy in developing visual and other aids for the teaching of mathematics. These include a series of film-strips on such subjects as the quadratic graph, from experiment to law, the history of calculation, an area construction, graphical solution of equations, permutations, an introduction to loci, how to read mathematical tables, and an introduction to the calculus. There is also a transparent 'Perspex' device containing coloured fluid which just fills a circular cavity; by tilting the device the fluid leaves this cavity and flows into another of rectangular shape, thus evaluating the area of a circle. The school also publishes *Mathematical Pie*, a small magazine containing a mathematical crossword and other material, chiefly of the puzzle type. Of course, similar activities are being carried on elsewhere, for example, in Switzerland, where J. L. Nicolet has produced a series of silent films which impart geometrical ideas by the dynamic method used in cartoon films. The time has now come to co-ordinate these activities. Those who are interested in the formation of an association for multi-sensory aids for the teaching of mathematics are asked to write to R. H. Collins, 47 Edward Avenue, Leicester.

Annals of Physical Medicine

The first issue of a new quarterly, the *Annals of Physical Medicine* (1, No. 1, 36; January 1952. 6*s*. net or 21*s*. net annual subscription. London: Headley Bros., Ltd.) marks the courageous decision of the British Association of Physical Medicine to publish its own journal. This Association was founded, as Lord Horder explains in his foreword to this issue, nine years ago "to encourage the study of the action of physical agents and their application in the promotion of Health; in the prevention and treatment of illness and injury; and in the restoration to fitness". Twenty-five years ago this kind of work was called physiotherapy, and the treatment given was passive, palliative and largely empirical, the bulk of the patients treated being chronic sufferers from diseases of the locomotor system. Nowadays physical medicine includes physical education, rehabilitation and resettlement, as well as the use of physical agents for both diagnosis and treatment; and many more diseases are nowadays treated by these methods. Research, as this issue of the *Annals* shows, is also a major activity of the members of the Association, and every effort is being made to improve the status of the specialist in physical medicine and to stimulate the universities to increase their efforts on behalf of what is, nowadays, an important branch of medicine. In this first issue of the *Annals* there are papers on the effects of microwaves and on the ambulant treatment of the complications of varicose veins and allied conditions that have defeated all surgical measures; and there are short reports on the International Federation of Physical Medicine, constituted in London in 1950, and on the International Congress of Physical Medicine to be held in London in July. The rapid expansion of this branch of medicine is a feature of modern medical development and deserves hearty and continued support.

Nest-Boxes

The British Trust for Ornithology (c/o Edward Grey Institute, 91 Banbury Road, Oxford) has produced a field guide to describe the best and simplest designs of nest-box shown by experience to be effective in attracting hole- or ledge-nesting species which the bird-lover may wish to encourage or the scientific bird-watcher to study more conveniently than is possible under natural conditions. It has been written by Edwin Cohen and Bruce Campbell and compiled from a variety of sources, published and unpublished, at the request of the Trust. Only designs which can be cheaply constructed have been included, while guidance is also given on the keeping of records and other types of artificial nest-sites. Each section is preceded by a tabular summary intended to help the observer to select quickly the designs most suitable for those species which occur in his neighbourhood and which he wants to attract to his boxes. A bibliography includes some references to books and papers dealing with the origins and history of nest-boxes.

The Worker in Industry

The ten centenary lectures for 1951, entitled "The Worker in Industry", which were given last year under the auspices of the Ministry of Labour and National Service in association with the Ministry's exhibition in London on "Manpower: the Human Factor in Industry", have now been collected in pamphlet form and made conveniently available to a wider circle than their original audiences (pp. 106. London: H.M. Stationery Office. 3*s*. 6*d*. net). Their keynote is practical rather than academic, and successive lectures deal with youth and man-power needs in Great Britain; eliminating the wastage of disablement; the effect of environment on the health and efficiency of the industrial worker; technical and scientific man-power; problems of wages policy; the contribution of the International Labour Organization; self-government in industry; the employment of the older worker; the human factor in accident prevention; and training for industry. A foreword contributed by Sir Walter Monckton expresses the hope that publication of the lectures will both stimulate thought and help to guide action in these matters.

Science Masters' Association: Annual Meeting of the Scottish Branch

The annual meeting of the Scottish Branch of the Science Masters' Association was held in University College, Dundee, during April 15–17, with Major-General D. W. Wimberley, principal of the College,

as president. In his address, General Wimberley pointed out that university training is a privilege not to be lightly wasted, and discussed the importance of selecting entrants to universities both on their academic standards and on their potentialities as responsible citizens with the character and inclination to take a leading part in their chosen careers. Three lectures were given at the meeting by, respectively, Prof. G. D. Preston, Harris professor of physics; Prof. D. H. Everett, professor of chemistry; and Prof. D. R. Dow, professor of anatomy. Prof. Preston spoke of the work in progress in the Department of Physics, much of which is concerned with the fine structure of matter, and an account was given of the many techniques being used, including electron microscopy and also X-ray diffraction by organic crystals, protein monolayers, bone structures and organic fibres such as jute. Prof. Everett discussed the teaching of quantum mechanics and modern valency theory, and outlined an approach which has been used in presenting the basic principles to first-year students using pictorial examples and mechanical models, all of which can be constructed in a school workshop. Speaking on "The Human Brain", Prof. Dow described various electronic methods of investigation and some of the striking results of the new knowledge obtained in these investigations carried out by Prof. W. Penfield, of Montreal, and others. In particular, he discussed recent work on the frontal lobes of the brain and the operation of leucotomy. During the period of the meeting visits were arranged to representative industrial undertakings in Dundee and the surrounding district, to the Pitlochry hydro-electric scheme and to St. Andrews University Observatory to see the new Schmidt telescope. One afternoon was set aside for conducted tours of the Botany, Zoology, Chemistry, Biochemistry and Physics Departments of University College, Dundee.

Metallurgical Conference in Reutte, Tyrol

Dr. Paul Schwarzkopf, president of the American Electro Metal Corporation, New York, and owner of the Metallwerk Plansee, Reutte, Tyrol, is organizing an international seminar on metallurgy, entitled "De re metallica", to be held in Reutte during June 22–26. The meeting will be divided into three sessions on physical metallurgy, hard metals and general powder metallurgy, respectively. A number of lectures will be given by scientific workers from Austria, Germany, Switzerland, France, Great Britain and the United States. Further details can be obtained from Dr. R. Kieffer, Metallwerk Plansee, Reutte/Tyrol, or from Dr. W. Leszynski, Powder Metallurgy Bulletin, 320 Yonkers Avenue, Yonkers 2, New York, or from Mr. M. Littmann, Metro-Cutanit, Ltd., 160 Piccadilly, London, W.1.

Overseas Scholarships of the Royal Commission for the Exhibition of 1851

The Royal Commissioners for the Exhibition of 1851 have awarded the following overseas scholarships for 1952, of value £450–500 a year and tenable for two years, for research to be undertaken in the institutions as shown. *Canada:* I. B. McDiarmid (Queen's University, Kingston, Ontario), nuclear physics at the University of Manchester; and R. S. Title (University of Toronto), physics at the University of Oxford. *Australia:* T. M. Dunn (University of Sydney), physical chemistry at University College, London, or the University of Cambridge; H. Hoffman (University of Melbourne), nerve physiology at the National Institute for Medical Research, London; and R. Pettit (University of Adelaide), organic chemistry at University College, London. *New Zealand:* R. B. Johns (University of New Zealand), organic chemistry at the University of Cambridge. *South Africa:* S. Brenner (University of the Witwatersrand), physiological chemistry at the University of Oxford; and A. R. H. Martin (Rhodes University, Grahamstown), botany at the University of Cambridge or University College, London. *Republic of Ireland:* D. H. Hayes (Trinity College, Dublin), organic chemistry at the University of Cambridge. *India:* H. K. Jain (Indian Agricultural Research Institute, New Delhi), plant breeding at the University College of Wales, Aberystwyth.

Announcements

The following appointments in the National Agricultural Advisory Service have been announced: A. Jones, to be chief farm-management advisory officer, in which post he will be responsible for developing and co-ordinating farm-management advisory work throughout Great Britain; and J. W. Reid, county agricultural officer for the County of Shropshire, to be deputy provincial director for the South-Western Provincial Sub-centre, Starcross, Devon.

The Challenger Society is offering small grants in aid of research in marine biology or oceanography at a recognized laboratory during the year June 1952–June 1953. Applications, accompanied by details of the proposed research, should reach the honorary secretary, Mr. N. B. Marshall, British Museum (Natural History), London, S.W.7, before the end of May.

The managers of the Broodbank Fund, which is for the furtherance of research in biochemistry or biophysics with special reference to the principles and practice of food preservation, are offering a research fellowship of value £600–1,000 a year (plus research expenses), tenable at the University of Cambridge for a maximum of three years. The closing date for applications is May 31. Further details can be obtained from the University Registry, Old Schools, Cambridge.

In memory of John Stewart Dow, the Illuminating Engineering Society is offering a prize, derived from a bequest by him, which it is hoped will encourage collaboration between students of illuminating engineering and students in other fields in which applied lighting plays an important part. The prize is of total value £75 and is intended primarily for students working in collaboration as a team. The subject this year is the layout, artificial lighting and decoration of a ground-floor showroom. Competitors must have been born on or after April 1, 1926. The closing date is November 30. Further details can be obtained from the secretary of the Illuminating Engineering Society, 32 Victoria Street, London, S.W.1.

Erratum. In the article on the Pacific Science Association in *Nature* of April 19, p. 659, it is stated that the United Nations Educational, Scientific and Cultural Organization contributed 20 million dollars to enable scientific workers from war-devastated countries to attend the Association's seventh congress (1949); this is incorrect, the grant made being 20 thousand dollars.

IONOPHORESIS OF SUGARS ON PAPER AND SOME APPLICATIONS TO THE ANALYSIS OF PROTEIN POLYSACCHARIDE COMPLEXES

By Dr. R. CONSDEN and WINIFRED M. STANIER
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SEPARATION of charged substances in solutions in an electric field, using various media which act as supports for the electrolyte, is now an established practice. Recently, paper has been found to be a suitable medium; originally employed for proteins[1–5], its use is being extended to other substances. In order to have a mobility, a substance must have a net charge. If the molecule contains equal numbers of basic and acidic groups, it may be made to acquire a net charge[6] by suitable adjustment of *p*H; many other methods are available for introducing charges such as oxidation[7,8]. With substances containing no ionizable groups, charges may be conferred by combination with charged groups[9]. Böeseken, in his classical work on sugar structure[10], showed that sugar molecules, containing hydroxyl groups suitably situated, can form complexes with borate ions. Differences in properties of borate complexes have been utilized to separate some sugars or their derivatives on chromatograms[11,12]. We have found that, in buffers containing borate, sugars will move towards the anode when a voltage is applied.

Ionophoresis was carried out under conditions rather similar to those of Cremer and Tiselius[3]. Whatman No. 1 paper 34 cm. long was dipped in buffer, blotted, and fixed in a rectangular glass frame. The frame and paper were placed in a rectangular glass dish. The purpose of the frame was to keep the paper stretched horizontally; the ends of the paper dipped into 'Perspex' troughs placed outside the dish, and these contained the buffer solution and graphite electrodes. After 10–15 min., 2 μl. of each sugar solution (1 per cent) was applied along the starting line 12 cm. from the cathode end of the paper, allowing 2 cm. between each. The dish was then filled with chlorobenzene until the paper was covered, and, after allowing a further ten minutes for equilibration, a potential of about 310 V. was applied from a rectifier for about two hours. All experiments were carried out at room temperature, and no special arrangement was made for controlling the temperature, which rose a few degrees during the run. The current usually increased by 30–40 per cent. The voltage did not vary by more than 2 per cent during any given run. At the end of the ionophoresis, the paper was removed and dried, and the sugars revealed by spraying with aniline hydrogen phthalate reagent[13] to which a few drops of glacial acetic acid had been added to overcome the alkalinity of the buffer. After a few minutes heating at 100–110°, the paper was viewed in ultra-violet light, in which the monose spots have an intense fluorescence. Prolonged heating is required for the oligosaccharides, which fluoresce comparatively weakly. In order to obtain a measure of electroendosmosis, creatinine or proline (the latter at *p*H values 8·6 or less) was included as a neutral substance. Alkaline picrate was used for revealing creatinine and ninhydrin for proline.

A series of ionophoreses in borate buffers at *p*H 7·0, 8·0, 8·6, 9·2 and 9·7 was carried out on the following sugars: fructose, sorbose, glucose, galactose, mannose, arabinose, ribose, rhamnose, raffinose and cellobiose. The solutions of *p*H 8·6 and less consisted of 0·2 *M* boric acid and 0·05 *M* sodium chloride, with various additions of 0·05 *M* borax. The latter was used for *p*H 9·2, and 0·1 *M* sodium hydroxide was added to this solution to provide the buffer of *p*H 9·7. For this series, the current and temperature of each experiment was similar, starting at 0·6–0·8 m.amp., depending on the buffer, and rising to 0·8–1·1 m.amp./cm. width. The temperature rose from 17–18° to 21–22°. The mobilities (cm.²/volt.sec.) were calculated from the distance between the sugar spot and proline or creatinine, the effective length of the paper (assumed to be 30 cm.), voltage and time. These figures are given in the accompanying table, and while they can only be very approximate, since effective length and voltage gradient were not accurately determined, they are useful for comparative purposes, as duplicate experiments gave reproducible results within 10 per cent, and the rates of the sugars relative to each other were always closely reproducible. In another experiment, at *p*H 8·6, the albumin of normal human serum migrated 6 cm. as compared with 8·5 cm. for glucose. Thus the calculated mobility of glucose is mobility of albumin $\times$ 8·5/6 = 9·2, using the value of $6{\cdot}48 \times 10^{-5}$ at 3° for albumin given by Kunkel and Tiselius[14]. This should be corrected for temperature, which in our experiments is about 17° higher than in Kunkel and Tiselius's conditions; and as mobility increases by about 2 per cent per degree rise, the corrected value becomes 12·3, which is in fair agreement with the value of 11·4 given in the accompanying table.

MOBILITIES OF SUGARS (cm.²/V.sec. $\times 10^5$) AT 20° IN BORATE AT VARIOUS *p*H VALUES, ON WHATMAN NO. 1 PAPER

*p*H	7·0	8·0	8·6	9·2	9·7
Fructose	8·2	9·7	11·4	12·5	13·1
Sorbose	8·7	10·4	12·2	14·1	14·3
Glucose	2·4	6·5	11·4	14·5	14·6
Galactose	2·8	5·8	9·6	13·0	13·1
Mannose	2·6	4·9	7·8	9·8	10·0
Ribose	7·0	9·1	10·2	10·9	11·0
Arabinose	3·2	6·5	10·3	13·3	13·9
Rhamnose	1·3	2·4	4·4	7·1	7·8
Cellobiose	<0·5	0·5	1·5	3·2	4·5
Raffinose	0·5	0·9	1·7	3·6	4·8

Fig. 1 is a photograph of ionophoresis at *p*H 8·6, and the mobilities are represented graphically in Fig. 2. In the absence of further experimental results, no explanation is attempted here to account for the differences between the various sugars, since the factors governing the mobility of any given sugar are obviously very complex, depending, among other things, on equilibria between different structures[10], and ionization constants of the borate complexes. Most of the sugar spots at the higher *p*H values were sharp and circular; but at the lower *p*H values some were rather elongated, suggesting the existence of more than one species of complex. That borate-complex formation is undoubtedly taking place and giving rise to mobility is evident from the fact that in buffers not containing borate (phosphate, barbiturate, glycine–sodium hydroxide) there was no migration. It can be seen from Fig. 2 that, except for the ribose and the ketoses, mobilities are small at *p*H 7, and increase with increase of *p*H. The curves for all the sugars are similar to the familiar titration curves of weak acids, and the shape of the ketose and

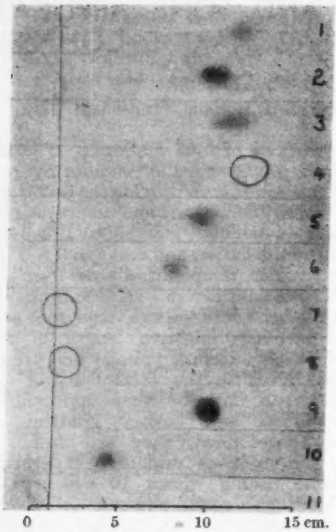

Fig. 1. Ionophoresis of sugars in borate, *p*H 8·6 at 10·3 V./cm for 120 min.
The origin is on the vertical line; anode at the right. Sugar spots revealed with aniline hydrogen phthalate, proline with ninhydrin; the weaker spots are outlined. 1, Fructose; 2, arabinose; 3, glucose; 4, sorbose; 5, galactose; 6, mannose; 7, cellobiose; 8, raffinose; 9, ribose; 10, rhamnose; 11, proline (spot is at extreme left centred over the zero)

ribose curves suggests the formation of more than one acid of different dissociation constants by each of these sugars.

Investigations at *p*H values less than 7 were also undertaken. Here, of course, it is not possible to use borate as a buffer. Phosphate at *p*H 6·0 and acetate at *p*H 5, both containing boric acid, were employed. In both cases, only the ketoses and ribose had any appreciable mobility. In boric acid alone, which has no buffering capacity (initial *p*H *c.* 5), the ketoses and ribose spots became very elongated, probably due partly to *p*H changes in the paper. There is evidence that the composition of the buffer solution itself may have an effect on the mobilities. Thus, at *p*H 8·0, in a solution containing strong borate ($M/2$ boric acid adjusted with $M/2$ sodium hydroxide), the mobilities of all the sugars were some 30 per cent higher than in the dilute buffer of same *p*H, except the ketoses and ribose, which showed no change.

By choosing appropriate conditions (*p*H and time), various sugar mixtures have been resolved. Sugars can be separated if their mobilities differ by 20 per cent or more. Of course, separations will not be practicable unless mobilities of some of the constituents of the mixture are sufficiently high. The two oligosaccharides, raffinose and cellobiose, have much smaller mobilities than the monoses at all *p*H values, and can therefore be separated. This applies also to lactose, maltose and sucrose, which, in a separate experiment at *p*H 8·6, had mobilities of 3·9, 2·7 and 0·9 respectively. Whether this low mobility is general for all neutral oligosaccharides cannot be decided without further investigation. Ribose, and the ketoses (which show similar behaviour to each other), migrate much faster than the other sugars at *p*H 8 and less. Of the hexoses, mannose is the slowest above *p*H 8 and can therefore be separated from them. 8·6 appears to be an optimum *p*H for the separation of glucose from galactose. Ribose and rhamnose, which, like glucose and galactose, are not always easily separable chromatographically, have widely differing mobilities. The separation of glucose and galactose, and of mannose, galactose and sorbose at *p*H 8·6, is illustrated in Fig. 3. Ionophoresis would thus appear to be a useful method for the separation of sugars additional to, or as a preliminary to, chromatography.

The hexosamines and hexuronic acids occur frequently in hydrolysates of animal polysaccharides, and if present these may readily be separated from neutral sugars in non-borate buffers because of their charges. At *p*H 8·6, in the absence of borate, glucosamine and galactosamine appear to be largely de-ionized, since they move only slowly towards the cathode; but in borate at this *p*H, these substances behave as neutral molecules, showing that formation of complexes has taken place. Glucuronic acid has a higher mobility towards the anode than any of the sugars in borate solutions, its rate relative to glucose at *p*H 8·6 being 1·4.

As stated above, certain sugar mixtures can be resolved by ionophoresis; further resolution can be obtained by paper chromatography. The same sheet of paper can be used for both processes, so that a two-dimensional separation is obtained. The sugar mixture is subjected to ionophoresis along a direction near and parallel with one edge of the paper, and, after drying, chromatography is carried out in a direction at right angles to the ionophoresis. The solvent mixture for the chromatography was equilibrated with buffer solution of the same composition as had been used for ionophoresis, instead of water. We have resolved various mixtures of sugars by this method, which recalls the rather similar process of simultaneous chromatography and ionophoresis used for amino-acids[15].

Many proteins contain only small amounts of bound polysaccharide, and examination of the sugars produced on hydrolysis of such compounds by paper chromatography is often rendered difficult, owing to the presence of relatively large amounts of protein-breakdown products, which may distort the movement of the sugars or obscure their colour reactions with reagents. It is thus often necessary to obtain

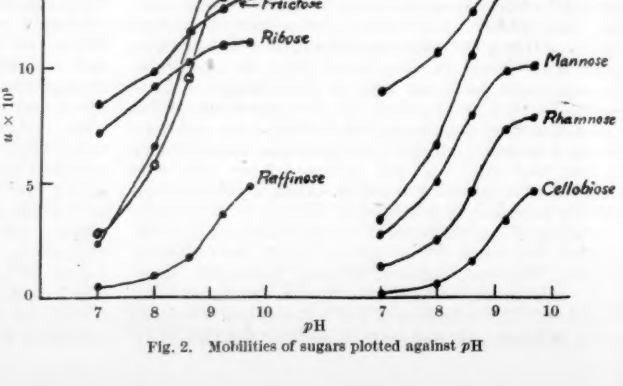

Fig. 2. Mobilities of sugars plotted against *p*H

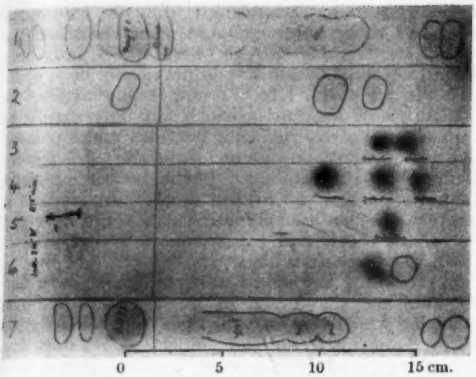

Fig. 3. Ionophoreses of protein hydrolysates and sugar mixtures in borate, *p*H 8·6 at 10·3 V./cm. for 215 min. Origin on vertical line; anode at the right. 1 and 2, Fibrin hydrolysate; 3, galactose + glucose; 4, mannose + galactose + sorbose; 5, galactose; 6 and 7, gelatin hydrolysate + galactose. Strips 1 and 7 were treated with ninhydrin; the two spots at the anode end are glutamic and aspartic acids. The other strips were treated with aniline hydrogen phthalate. The weaker spots are outlined. All the ionophoreses were carried out simultaneously on one sheet

polysaccharide-rich fractions before chromatography, a procedure which cannot always be employed if only limited amounts of starting material are available. Ionophoresis overcomes this difficulty, since the sugars in the hydrolysate can be separated from much of the interfering amino-acid and peptide material; thereafter chromatography may be employed, if desired, to effect further separation. At *p*H 8·6, for example, only peptides of glutamic and aspartic acids will migrate to positions similar to most of the monoses, and these peptides will usually not be present in sufficient amounts to interfere with subsequent chromatography; glutamic and aspartic acids move somewhat faster than the sugars. It has been our custom to employ a *p*H of 8·6 for the preliminary examination of protein hydrolysates, since mobilities of most of the sugars are relatively high. At higher *p*H values there is a risk of decomposition of some of the sugars, and the mobilities of some peptides or amino-acids may be much increased owing to de-ionization of their amino-groups. However, the optimum *p*H might well be different from 8·6, depending on the particular sugars present.

The duration of ionophoresis will also depend on the particular sugars present. For hexuronic acid only a comparatively short period is sufficient, if necessary, on a separate ionophoresis. In the presence of much protein hydrolysate, it has been observed that a given sugar tends to migrate at a somewhat smaller rate than in the absence of protein. This is evidently due to the local lowering of the *p*H by the relatively large amount of amino-acid and peptide material, and therefore lowering of sugar mobility. This effect can largely be eliminated by allowing sufficient time for equilibration on the paper before commencing ionophoresis. Nevertheless, it is important, when examining protein-polysaccharide hydrolysates, to employ controls of similar composition, rather than solutions of sugars alone. For this purpose we employ a hydrolysate of gelatin containing 1–2 per cent of added sugar. Where two-dimensional separations are carried out, a control mixture of sugars is included on a suitable part of the same sheet in the chromatographic stage.

The protein-polysaccharide was hydrolysed with *N*-sulphuric acid for 3 hr. at 100–110°. After careful neutralization with baryta, the filtered solution was concentrated *in vacuo* to small bulk. Ionophoresis in borate buffer *p*H 8·6 was then carried out, using an amount of hydrolysate corresponding to about 1 mgm. of original material. Duplicate strips were treated with ninhydrin to reveal amino-acids and peptides (cf. refs. 4 and 16), as the position of the sugar spots relative to these provides useful additional information. Where two-dimensional separations are carried out, the same sheet, after treatment with aniline hydrogen phthalate, may then be sprayed with ninhydrin. The presence of aniline hydrogen phthalate inhibits the full development of the ninhydrin colours.

We give two examples of the application of these methods. The first was a group *A* hæmolytic streptococcus hydrolysate. Ionophoresis showed the presence of at least four sugar components, which migrated similarly to hexosamine, rhamnose, ribose and glucose. These sugars were confirmed by their colours with aniline hydrogen phthalate, and by two-dimensional separation. As judged from the intensities of the spots, rhamnose was present in highest amount, while the amounts of glucose and hexosamine were similar to each other. Ribose was relatively weak, and appeared to vary in amount with different strains. Recently, Schmidt[17] has reported that group *A* streptococcus polysaccharide is composed chiefly of rhamnose and glucosamine.

The second example is human fibrin. This was obtained from normal citrated serum by addition of thrombin, and was purified by dissolving in chloracetic acid and precipitation with trichloracetic acid according to the method of Lorand[18]. This procedure was repeated four times, after which the reducing sugar[19] and hexosamine[20] liberated on hydrolysis were constant. The final values were 2·7 and 0·6 per cent, respectively, based on the air-dry fibrin. A preliminary ionophoresis for a short time indicated the absence of uronic acid. Further ionophoresis for longer periods indicated the presence of three sugars migrating at rates similar to hexosamine, mannose and galactose. This is illustrated in Fig. 3. (The control—gelatin hydrolysate and added galactose—shows the presence of a trace of another sugar, probably glucose, which was present in the gelatin.) Two-dimensional separation confirmed the presence of galactose, mannose and hexosamine. Fibrin thus appears to contain a few per cent of bound polysaccharide consisting of these three sugars. Similar findings, by chromatography, have been recorded for other blood proteins[21]. The further investigation of fibrin polysaccharide is being continued.

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THE TEXTILE INSTITUTE

By Prof. W. E. MORTON
College of Technology, Manchester

In 1910 the Textile Institute, the professional body of textile technologists, was founded "to advance the general interests of the textile industry, more particularly in relation to the acquisition and application thereto of scientific knowledge". On April 4, 1952, its new headquarters at 10 Blackfriars Street, Manchester, were officially opened by the president, Mr. G. H. Spencer, at a ceremonial unveiling of a tablet commemorating the names of the fifteen founding members.

The necessity for new and more commodious premises has arisen mainly because of the remarkable post-war growth of the Institute's membership and activities. In its early days it developed slowly: when it received its Royal Charter in 1925 its membership was just over 1,000, and by 1939 this number had increased to 1,700. But since 1946 no less than 4,637 new members have joined, and the current membership of more than 5,600 is still growing at the rate of a hundred or so a month.

This rapid expansion is in part due to the growing recognition that industries in general, and the traditional industries in particular, depend very largely for their future prosperity on a more widespread application of science and the scientific method of approach to the problems of their materials, processes and organization. But it is also due to the part which the Institute itself has played in developing this climate of opinion, and to the high esteem in which its *Journal* and its diplomas have come to be held by textile technologists throughout the world. It is not, and never has been, a purely national body—a fact which is symbolized in the crest of its arms. More than a thousand of its members, including 271 fellows and associates, are drawn from overseas, and in recent years its examinations for the award of diplomas have been held at centres in seventeen foreign countries. The *Journal*, which is the official organ of publication for the several textile research associations, is universally acknowledged to be without equal in the textile field, both for the quality of the papers contributed and for its abstracts of current textile literature, which are immeasurably more comprehensive than anything of the kind published elsewhere.

Besides setting up high standards of technical literature through its *Journal*, and of professional competence through the award of diplomas, the Institute serves the purposes laid down in its charter in many other ways: by the award of scholarships and prizes; by the unification of testing methods; by the codification of textile terminology; and by the organization of conferences and lectures. In the conduct of its affairs, the Council is assisted by fourteen standing committees with their numerous subcommittees and overseas advisory panels; and as the membership has grown so also have the demands upon the Institute's resources—in offices for the expanding staff and meeting rooms for the greatly increased amount of committee work that has to be done.

Since the Second World War, the old premises in St. Mary's Parsonage, considered even in 1925 to be "none too commodious", have been quite inadequate for their purpose, and administration has had to be carried on under increasingly difficult conditions. Staff had to be accommodated wherever there was space, and serious inroads were made into such limited accommodation as had previously been available for members. In its new headquarters, the Institute now has offices which not only satisfy its administrative requirements but also make possible the restoration and augmentation of the general facilities for its members. Particularly appreciated among these are the lecture theatre to seat 165 in comfort, the handsomely furnished members' room, the dining-room, and the adequate housing of the Institute's extensive library.

The opening ceremony was performed at a convocation for the award of medals and diplomas, following which the assembly was addressed by Dr. Percy Dunsheath on the subject of "Education, Technology and Management". Dr. Dunsheath's theme was the relatively low esteem in which technological studies are held in Great Britain as compared with the United States and elsewhere. Though the situation is improving, he said, there are still far too many in a position to influence the careers of young men who are apt to look down on any sort of education that is directed to a useful end. This, he contended, is a state of affairs that must be rectified, and quickly, if Britain is to maintain itself in the forefront of industrial nations. Technological education, based as it must be on a sound foundation of fundamental science, has every right to claim a status on a par with that of any other form of academic study; and unless it is accorded that recognition, industry would fail to attract its due share of the best brains in Britain, by which alone it can survive in the face of modern world competition.

EDUCATION GROUP OF THE INSTITUTE OF PHYSICS

ANNUAL CONFERENCE

School and university examinations in physics were discussed at the annual conference of the Education Group of the Institute of Physics, held at the Institute's House during April 17–19. The opening paper by Mr. J. L. Brereton (general secretary, Cambridge University Local Examinations Syndicate) on "The Place of Examinations in Education", explained the aims of a school examination. It is the modern equivalent of the master's criticism of his apprentice. The external examination goes further, in that it tests teachers as well as pupils, and can exert a profound influence for good on the courses of study in schools. The General Certificate of Education, which can be taken in single subjects and not necessarily from school, does not of itself imply the completion of an approved course; and only by close co-operation between examining bodies and the schools can its value be maintained. Mr. Brereton said he believes that group intelligence tests are similar in nature to conventional examinations, but at a very low level of knowledge. He had experimented with an interchange of papers with American schools, and the results so far suggested a high correlation between marks obtained in the General Certificate papers and in their objective tests. He believes there must eventually be a move towards the establishment of internal examinations conducted

by the schools under the supervision of the examining bodies.

The second session, on "School Examinations", was opened by Dr. T. L. Ibbs (University of Birmingham), who agreed with many of the points in Mr. Brereton's paper. He regretted some of the recent alterations in school examinations, particularly the abolition of the distinction mark, which had been a help to universities in selecting entrants although it reflected the proficiency of a school's coaching as well as the promise of a candidate. Mr. E. W. Tapper (Dulwich College) described the organization of the internal examinations at Dulwich, which are conducted in the atmosphere of a public examination and give the pupils some training in examination technique—an art that can and should be taught. Mr. W. B. Chivers (King Edward's Grammar School, Aston, Birmingham) spoke on practical examinations. He urged that separate papers should be set for 'advanced' and 'scholarship' candidates, that the marks should be assessed apart from the theory papers, and that the result of the practical examination should be recorded on the certificate. Many boys have outstanding practical gifts, and little aptitude for theory; there is a demand for these gifts in many industrial careers, and the certificate should state them. The difficulties of staging a practical examination for many candidates, with limited space and resources, were recalled with great good humour.

Prof. W. E. Curtis (president of the Institute of Physics) opened the discussion on these papers. He felt that there is little difference, as affecting university entrants, between the General Certificate of Education and the older form of examination, and endorsed Mr. Chivers's suggestions for improving the practical papers.

University examinations for honours students were the subject of the third session. Prof. Curtis said that the usual written examination lays too much stress on memory, and leaves too little time for thinking; it also leads the undergraduate to adopt wrong methods of study aimed at forecasting likely questions. He described the system used in the University of Durham at King's College during the honours course for developing and testing the student's powers of original thinking, and resource in practical work. Dr. J. G. Wilson (University of Manchester) said that the final honours examination tests a man's fitness to enter the profession of physics. Apart from the qualities mentioned by earlier speakers, one important skill is his ability to communicate his knowledge. Many good students have a poor command of English; is this a matter to be rectified at school, or at the university? Little originality can be expected in specialized branches of physics; but students ought to be able to apply their knowledge of the elementary ground-work of physics in an original way, and examination questions could be framed so as to test this ability.

The discussion centred first on Dr. Wilson's point about the low quality of written English prevalent among science students. Mr. R. Stone (Manchester Grammar School) said that this is a matter for the universities; the good scientist is often a 'late developer' in English, and can quickly be trained in this when the time is ripe. Dr. H. R. Lang (secretary of the Institute of Physics) said that the real need is a command of functional English, an ability to write clear and concise reports. Returning to the main subject, Dr. J. Topping and Dr. R. Fürth spoke of the Continental system of oral examinations as perhaps a better way of assessing candidates but less favoured by candidates themselves.

University examinations also occupied the final session. Dr. W. H. Taylor (University of Cambridge) described the aims and organization of the practical examinations in physics for the Natural Sciences Tripos, and Dr. A. J. Woodall (Military College of Science, Shrivenham) spoke of examinations in physics for the non-specialist, quoting some very simple questions which could be set to test a candidate's grasp of elementary principles, and which did indeed cause his hearers some moments of hard thinking.

All the speakers were concerned with the use of examinations as a part of the technique of education, and this positive and constructive attitude was evident throughout the discussions. A valuable feature of the conference was the exchange of views and experiences between teachers and examiners of physics at all academic levels. G. R. NOAKES

ASLIB AERONAUTICAL GROUP

CONFERENCE AND ANNUAL GENERAL MEETING

THE Aslib Aeronautical Group held its first conference and annual general meeting at the College of Aeronautics, Cranfield, during April 5–7. The forty-eight delegates represented many aircraft and accessory manufacturers, airlines, experimental establishments and other bodies interested in the supply and use of aeronautical information. They were welcomed to the College by Air Chief Marshal Sir Edgar Ludlow Hewitt, chairman of the board of governors, and Air Marshal Sir Victor Goddard, principal of the College.

The programme included a talk by Mr. P. L. Taylor on electrical engineering as applied to aircraft, and Mr. A. H. Holloway (Technical Information Bureau) and Mr. J. G. Ogg (Central Radio Bureau) outlined the scope and functions of their respective departments in the Ministry of Supply.

The Group was fortunate in having as its guests Dr. A. C. de Kock and Dr. R. Timman, both of the Nationaal Luchtvaartlaboratorium, Holland, and co-authors of the N.L.L. scheme for the analytical cataloguing of wind-tunnel and other empirical aerodynamic data (NLL Report *F*64). One of the three working parties recently formed by the Group had been asked to examine the scheme in detail, and at the meeting it presented its interim report. General reactions were favourable: it was agreed that normal library classification systems are unsuitable for this special purpose, and the Dutch index cards, each giving an illustrated analysis of one scientific report, would be generally acceptable provided that minor improvements can be made in the physical process of selection. It was suggested that edge-notched or punched cards might be used.

The working party dealing with abstracts, in its interim report, outlined the steps taken to ascertain requirements for aeronautical abstracting services. This has been done by distributing with *Index Aeronauticus* seven hundred copies of a questionnaire. Replies indicate that present needs can be met by some improvement in the *Index Aeronauticus* itself rather than by the initiation of a new venture.

The third working party, that engaged on periodicals, reported that considerable progress has been made in the preparation of a union catalogue listing the holdings of each aeronautical library. This is already facilitating loans and exchanges between libraries, and might later result in the co-operative purchase of periodicals for which only a small demand exists.

The programme of official meetings concluded with a general discussion on the need for uniformity in classification and in methods generally. There was a suggestion that abstract cards, suitable for use in a standard 5 in. × 3 in. card index, should be issued as part of R.A.E. reports: this received enthusiastic support, particularly from librarians who use the Universal Decimal Classification adopted some years ago by the Ministry of Supply.

The morning of April 7 was spent in a conducted tour of the College Departments, including those of Aerodynamics, Design and Propulsion, and the sections dealing with Standards and Business Systems.

The Aslib Aeronautical Group intends to hold further week-end meetings of this nature. Those interested should write to the honorary secretary, Mr. C. W. Cleverdon, Librarian, College of Aeronautics, Cranfield, Bletchley, Bucks.

SMITHSONIAN INSTITUTION

ANNUAL REPORT FOR 1950–51

THE report of the Secretary of the Smithsonian Institution for the year ended June 30, 1951*, with which is included the financial report of the executive committee of the Board of Regents, refers to the deferment of some of the Institution's long-term programmes, such as modernization of museum exhibits, construction of urgently needed new buildings, and purchase of modern instruments and laboratory equipment, caused by the curtailment of Government spending since the Korean crises. The position is the more serious because the annual number of visitors is rapidly approaching three millions, and the increase of the collections in the fields of natural history, industry, history and aeronautics has long since crowded all available storage space. The Adams–Clement collection, one of the most important historically to come to the Institution in recent years, was formally opened in April. Accessions to the National Museum during the year totalled 303,000, including further archæological material from Neolithic sites in Honshu, Japan, many mammals, birds and marine invertebrates from Labrador and Newfoundland, a comprehensive collection of fishes, crustaceans, molluscs and miscellaneous invertebrates from the Gulf of Mexico, several important collections of insects and more than 16,500 plants in exchanges with other institutions, and a collection of historical electronic and electrical apparatus. Field-work was conducted by the staff in Cuba, Panama, Costa Rica, Honduras, Colombia, South Africa, Southern Rhodesia, British North Borneo and many parts of the United States.

The director of the Bureau of American Ethnology continued his archæological work on the Atlantic coast of Panama, and a second season of field-work on Cornwallis Island in the Canadian Arctic yielded a large collection of the Thule culture material. The first five volumes of the "Arctic Bibliography" on which the Arctic Institute has been engaged for the past five years were completed and delivered to the Government Printing Office, Washington, D.C. The collection of the first volume of River Basin Surveys papers was also completed; since the beginning of this field-work 2,894 archæological sites have been located and recorded, of which 545 have been recommended for excavation or additional testing. The excavation work during the year covered twenty reservoir areas in ten States, and the work of the twenty-six excavating parties is described in considerable detail in the appended report on the Bureau. The Institute of Social Anthropology continued its research and teaching programme in Brazil, Colombia, Guatemala, Mexico and Peru.

The International Exchange Service handled the record number of 1,011,000 packages of publications, an increase of 1,375, although the actual weight decreased. No shipments were made to China or Rumania. One hundred and two sets of United States official publications are now supplied to other countries in exchange for similar publications, sixty-one of these being full sets, while eighty-five copies of the Federal Register and ninety-two of the Congressional Record are also supplied. A list of repositories is included in the report. The National Zoological Park, which received some 3,460,400 visitors during the year, housed 2,813 animals at the end of the year, additions of 1,768 balancing the losses and removals of 1,776. The Astrophysical Observatory continued its studies of solar radiation at the high-altitude stations at Table Mountain, in California, and at Montezuma, Chile, and at the former a method is being developed for determining ozone in the upper atmosphere by spectrobolometric measurements. Some work was done on the improvement of the melikeron for measuring outgoing radiation, and two silver-disk pyrheliometers were under construction. The Division of Radiation and Organisms has begun a series of biochemical investigations of photomorphogenesis in green plants. Thirty-three scientific workers used the facilities for biological research at the Barro Colorado Island station.

* Report of the Secretary of the Smithsonian Institution and Financial Report of the Executive Committee of the Board of Regents for the Year ended June 30, 1951. (Pub. 4056.) Pp. ix+160. (Washington, D.C.: Government Printing Office, 1952.) 55 cents.

ADVANCES IN PHYSICS

A NEW QUARTERLY JOURNAL

THE long-established *Philosophical Magazine* needs no recommendation to mathematicians and physicists, and any new venture under the auspices of this journal is sure to be of high standard and most welcome. *Advances in Physics**, the new quarterly supplement of the *Philosophical Magazine*, has for its purpose the publication of articles which are written by experts for experts, and in which topics of current interest in physics, covering theoretical and experimental aspects in addition to certain branches of applied mechanics, are reviewed. In order not to clash with similar, though annual, periodicals such as *Reports on Progress in Physics* of the Physical Society, the contributions to *Advances*

* *Advances in Physics*. A Quarterly Supplement of the *Philosophical Magazine*. 1, No. 1 (January 1952). Pp. iv+110. (London: Taylor and Francis, Ltd.) 15*s*., or 55*s*. a year.

in Physics are to be restricted to those of specialist standard, and will deal with subjects in rather narrow fields. They will be of admittedly ephemeral value; but the aim is to publish them quickly. So far as possible, it is intended to group the papers so that the contributions in each issue will deal with topics in one particular field; for example, in No. 1 they deal with problems in the physics of the solid state, and in further issues the properties of liquid helium, the theory of dislocations and the science of the upper atmosphere will be the underlying themes.

In the first of the three articles in the first number, entitled "The Mean Free Path of Electrons in Metals", by Dr. E. H. Sondheimer, the effect on the electrical conductivity of reducing the dimensions of the conductor so that the mean free path of the electrons is comparable in magnitude with the thickness of the specimen is considered. In addition, the more complicated effects introduced when the thin specimen is placed in a magnetic field, and the so-called anomalous skin-effect, are discussed. The importance of, and the need for, additional experiments at low temperatures are stressed.

The second article is by Prof. F. Seitz, and is on the generation of vacancies by moving dislocations. New evidence is cited which confirms Prof. Seitz's view that vacant lattice-sites are generated during plastic flow in ductile crystals, particularly in metals. The origin of work-hardening in single crystals is discussed, and several alternative interpretations which would assist in deciding what essential part vacancies play in the cold-working of materials are presented. Finally, several experiments, typical of those which could prove decisive in isolating the influence of vacancies, are proposed.

Between 1920 and 1948 the theory of the growth of ideally perfect crystals was greatly developed, and, based on these results and using the concepts of step and screw dislocations, Dr. F. C. Frank has produced during the past year a theory of the growth of imperfect crystals which seems to give answers to many puzzling questions. Observations on beryl, carborundum, cadmium iodide and other crystals have given remarkable verification of Dr. Frank's suggestions. The third and final article, on crystal growth and dislocations by Dr. Frank, is therefore most valuable and timely. The underlying concepts are clearly explained, the theory so far as it has been developed is briefly reviewed, and the essential points to be noticed in the various experimental observations are carefully pointed out. The range of application of the present theory is finally considered, and the relation of supercooling to the growth of crystals from the melt is very briefly—all too briefly—mentioned.

KOSSUTH AWARDS IN HUNGARY FOR 1952

WINNERS of the 1952 Kossuth Awards in Hungary, which are given for outstanding work during the past year, have recently been announced. One award is for 50,000 forints, fourteen for 20,000 forints and sixty-eight for 10,000 forints, making a total of slightly more than a million forints (about £30,000). The Awards are divided between four sections on medicine and natural science, social science, art and literature, and social reconstruction, respectively; these are subdivided by subject and the Awards for science and technology are as follows, the value being 10,000 forints except where otherwise stated. *Medicine:* Prof. I. Törö, for the discovery of a new cell-division mechanism (20,000 forints); Prof. F. Kiss, for research on the nervous system and lymphs; Prof. B. Issekutz, sen., for achievements in the field of the pharmacy of quaternary ammonium bases and the developing of the Hungarian pharmaceutical industry; Prof. G. Ivanovits, for the isolation of vitamin B_{12}. *Technical Sciences:* Prof. E. Vadász, for work on the genetic theory of Hungarian manganese ores, and for his book "Bauxite Geology" (20,000 forints); Prof. E. Szádeczky-Kardoss, for research and publications on lignite petrology (20,000 forints); Prof. P. Esztó, for theoretical and practical research on rock movements occurring in mines; Prof. G. Pattantyus, for research on cavitation streams of water-turbine blades; E. Mosonyi, director of the Hydraulic Power Planning Office, for hydrological research on the regulation of the Rivers Danube and Tisza; L. Forgó, deputy director of the Thermotechnical Institute, for development of the theory of small ribbed thermal exchangers. *Mathematics:* Prof. P. Turán, for work on mathematical analysis (20,000 forints); Prof. O. Varga, for work on differential geometry, especially the Finsler spaces; T. Szele, university lecturer, for structural research on the theory of Abel groups and, in particular, for the discovery of analogies with the theory of bodies. *Physics:* Prof. P. Selényi, for research and publications on optics; Prof. K. Simonyi, for the construction of high-voltage accelerators. *Chemistry:* Prof. G. Schay, for thermodynamical and experimental research on the elasticity and plasticity of rubber, and its practical application; Prof. S. Szalay, for geochemical research. *Agricultural Science:* Prof. S. Jávorka, for plant research. *Metallurgy and Machine Industry:* E. Ács, director of the Instrument Industry Research Institution, for the manufacture of 24-channel seismograph installations, and other discoveries (20,000 forints); Mrs. A. Tasnádi, head of the metallographic laboratory of the Mátyás Rákosi Works, for the development of methods of the surface protection of metals; Dr. J. Lukács, engineer, and E. L. Bochner, departmental head, both of the Electrical Industry Central Research Laboratory, for work on the economy of copper in electrical installations and on the production of high-voltage resistances. *Mining and Power Industries:* Prof. J. Varga, for research, theoretical and practical, in organic chemistry (20,000 forints); Dr. A. László, chemical research engineer at the Research Institute for Heavy Chemical Industry, for chemical research; Dr. Z. Földi, engineer in the Chinoin factory, for research on penicillin and its manufacture, and other factory processes; G. Nagy, investment manager of the Borsod Co-operative, for work on the gasification of lignite and its pilot-plant application. *Agriculture:* A. Porpáczy, of the Fertöd Experimental Farm, for work on the establishment of new types of fruits, and on the acclimatization of the lemon (20,000 forints); V. Westsik, of the Nyiregyháza Sand Improving Experimental Farm, for work on improving the agricultural yield from loose, sandy soils (20,000 forints); Dr. J. Mócsy, professor of internal diseases in the Veterinary Faculty of the University of Agricultural Sciences, for his method of protection against external parasites.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Production of a High Resolving Power by means of Multilayer Coatings

Many astrophysical problems, for example, Zeeman-effect studies of the solar disk and the structure of some of the Fraunhofer lines, necessitate a very high resolving power, of the order of 10^5, for the spectrographic equipment.

For several instruments, in particular the Fabry–Perot interferometer, the resolving power increases rapidly with increasing reflectivity of the surfaces. However, in the case of silver films, which have hitherto been used for the reflecting surfaces, the useful upper limit for the reflexion coefficient is reached at $R = 0{\cdot}90$, because the transmission coefficient[1] is then small, about 0·045. Hence, 5·5 per cent of the incident light is absorbed by the metal film. The resolving power for such a coating, using a 0·75-cm. étalon, is theoretically 672,000 at $\lambda = 5500$ A.; but this value is not attained in practice owing to imperfections of the optical surfaces.

Since the reflectivity at the interface between two transparent media is proportional to the square of the difference of their refractive indices, it is possible to achieve very high reflectivities with successive alternate layers of high and low refractive index dielectrics of a suitable thickness. For maximum reflectivity the requisite optical thickness is $\lambda/4$.

Quarter-wave coatings of cryolite (index of refraction 1·36) and zinc sulphide (index of refraction 2·37) as deposited by evaporation *in vacuo* are eminently suitable for this purpose. Banning[2], in 1942, using a visual method of thickness control, successfully produced a multilayer coating possessing the anticipated high reflexion coefficient, the absorption being reported as negligible. However, the change of the interference colours of thin films of high index with thickness is not very pronounced for thicknesses less than approximately $\lambda/4$. Dufour[3] overcame this lack of precision by recording the variation in reflectivity of the thin film during its deposition, the reflected intensity being a minimum in the case of a quarter-wave coating of transparent dielectric of lower index than its glass supporting base. For the zinc sulphide the amount of reflected light is a maximum when the optical thickness is $\lambda/4$.

At the St. Andrews University Observatory an evaporation plant has been installed and suitably modified to produce dielectric coatings of controlled thickness, the arrangement being similar to that of Dufour. The accuracy has been investigated by measuring independently the thickness of the deposit by an interference method, the deviation from the desired thickness of $\lambda/4$ being not more than 4 per cent.

We owe to Dr. W. L. Wilcock, of the Physical Laboratories, University of Manchester, the suggestion that since the coatings were to be used in a Fabry–Perot interferometer, the determinations of the reflexion, transmission and absorption coefficients should be performed under similar conditions.

Composition of coating	Reflexion (per cent)	Absorption (per cent)	Transmission (per cent)
5 quarter-wave layers of zinc sulphide 4 quarter-wave layers of cryolite	97	2	1
4 quarter-wave layers of zinc sulphide 3 quarter-wave layers of cryolite	94	1	5

Photometric measurements have confirmed the superiority of the new multilayer coatings over silver films, typical values for the mercury 5461 line being as shown in the table.

The keeping properties of the new coatings is excellent, no deterioration occurring over several months.

Further experiments, with enhanced metal films, that is, silver plus layers of dielectric films, have indicated that owing to the very small absorption of the dielectrics it is possible to increase the overall reflectivity of the coating without adding to the absorption.

A pair of high-quality ($\lambda/40$) crystalline quartz optical flats, coated with four zinc sulphide and three cryolite quarter-wave layers, arranged in a Fabry–Perot étalon (fused silica spacer, 0·75 cm. thick) for examination of the 5461 mercury line, was found to give a resolving power of at least $1{\cdot}0 \times 10^5$. These flats have been incorporated into the solar spectrograph at the Cambridge University Observatory.

Experiments for the application of such plates in the focal plane of telescopes are proceeding.

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Oct. 17.

[1] Tolansky, S., *Physica*, **12**, 650 (1946)
[2] Banning, M., *J. Opt. Soc. Amer.*, 792 (1947).
[3] Dufour Ch., *Le Vide*, Nos. 16–17, 480 (1948).

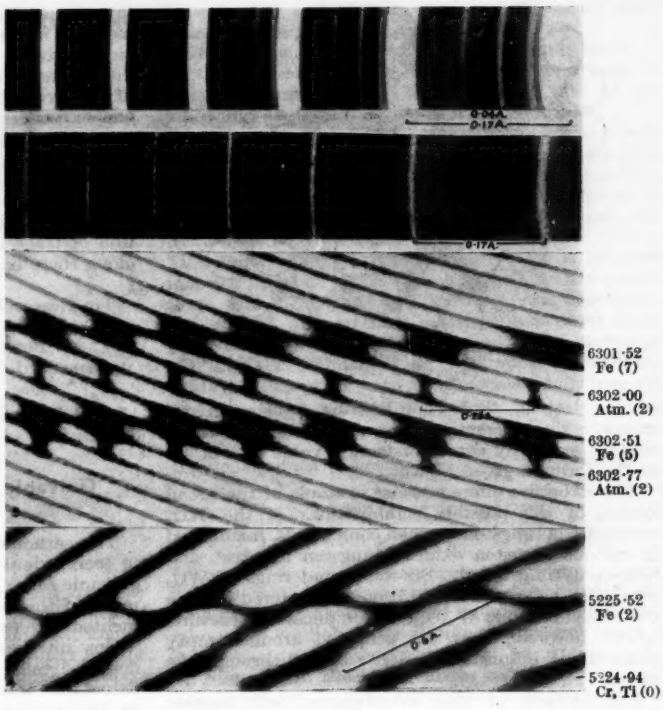
When one applies the Fabry–Perot interferometer to absorption spectra, as has been done with some success in solar physics[1], high reflectivity and small absorption are essential if high resolving power is required. This is partly because one is compelled, in nearly all such cases, to use in combination with the interferometer a rather powerful auxiliary spectrograph, which in itself causes a considerable loss of light. Also, one can attain greater resolution only to a very limited degree by increasing the separation of the Fabry–Perot plates, because the greater separation reduces the range of the interferometer. It is well known that this range should be in a certain useful ratio to the intensity (or width) of the absorption line under investigation[1]. There is, in addition, an important connexion between the maximum plate separation (which determines the range) and the instrumental line-width of the auxiliary spectrograph[2]. The result is that in the visible spectrum the separation should not exceed about 10 mm. in air.

A. H. Jarrett's multi-coated interferometer, which has been described above, has a considerable superiority over the usual silver-coated interferometer in the desired direction, that is, it is of high reflectivity

and low absorption. It has recently been tested with the McClean plane-grating spectrograph at the Cambridge Observatories, chiefly in order to investigate its suitability for the measurement of small line displacements (Zeeman effects) in the solar spectrum. The results appear very promising, and some of the tests are illustrated here with the aid of enlargements from the original photographs.

Fig. 1 shows the typical structure[3] of the mercury line 5461, from an ordinary water-cooled mercury lamp. Numerous fine details due to the various isotopes are unfortunately lost in the reproduction.

Fig. 2 shows a similar photograph of the same line from a water-cooled mercury-198 isotope lamp, supplied by the G.E.C. Research Laboratories, Wembley. Both photographs were taken with a 0·75-cm. spacer in air, giving an interferometer range of 0·17 A. The line-width in the third ring of Fig. 2, determined by micrometer measurements on several original plates, is about 0·005 A. The resolving power therefore slightly exceeded 1,000,000. The mercury lamp was made to form an image on the interferometer so as to use a plate area of between 5 and 7 mm.² only. Similar photographs were taken under normal conditions, after decreasing the light intensity so that exposures went up to 60 min.; but even then the quality of the line had not deteriorated, so far as could be ascertained.



The durability of the surface has been better than expected. The plates when out of use have been stored in an air-tight jar. Upon repeating the mercury photographs after four months, the quality of the lines showed no appreciable change, although the interferometer had meanwhile been used frequently for solar observations.

Fig. 3 illustrates the application of the interferometer to the solar absorption spectrum. The auxiliary spectrograph used a plane grating at $f/60$, in the second order, and the interferometer was placed behind the spectrograph focal plane, in a parallel beam produced by auxiliary lenses. The spectrograph slit-width was 0·12 mm.; the interferometer range in this wave-length region (λ 6300) is 0·26 A. A lens of 50 cm. focal length was used to observe the fringes. With a comparatively insensitive emulsion (Ilford Thin-Film Half-Tone Panchromatic) the exposure times for the sun's centre were about 10 min. Fig. 3 shows the atmospheric absorption line λ 6302·00, of Rowland intensity 2, giving extremely sharp and well-measurable interference knots, corresponding to a line-width of about 0·03 A.

Fig. 4 is from a series of plates obtained with the same optical arrangement. It shows, highly magnified, very sharp interference knots from the solar iron line, λ 5225·53, of Rowland intensity 2. The line is situated in this case near the centre of the heterochromatic fringes described by Treanor[2]. The slit-width of the auxiliary spectrograph was 0·06 mm.; the interferometer range was 0·15 A. A lens of focal length 25 cm. was used to observe the fringes, and the exposure time was 10 min. on the rather slow Ilford Thin-Film Half-Tone plate.

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The Observatories,
University, Cambridge.
Oct. 25.

[1] For example, Burns, K., *et. al.*, *Pub. Alleg. Obs.*, **6**, No. 7, 105 (1925): No. 8, 125 (1927); No. 9, 141 (1928). St. John, C. E., *Astrophys. J.*, **67**, 195 (1928). Shane, C. D., *Lick Obs. Bull.*, **16**, 76 (1932); **19**, 119 (1941). von Klüber, H., *Z. Astrophys.*, **25**, 187 (1948). Adam, M. G., *Mon. Not. Roy. Astro. Soc.*, **108**, 446 (1948).

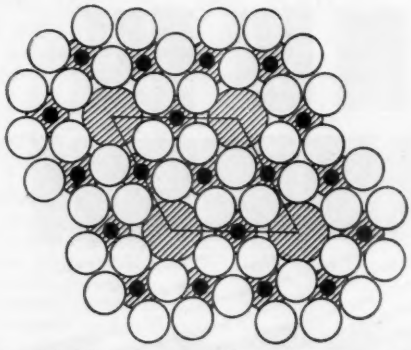
[2] Treanor, P. J., *Mon. Not. Roy. Astro. Soc.*, **109**, 380 (1949).

[3] For example, Schüler, H., and Keystone, J. E., *Z. Phys.*, **72**, 423 (1931).

Tungsten Bronzes containing Six-membered Rings of WO_6 Octahedra

POTASSIUM, rubidium and cæsium form dark blue, hexagonal tungsten bronzes Me_xWO_3, where the alkali content, which is probably somewhat variable, corresponds to values[1] of x of about 0·3. The crystal structure of these compounds, which are isomorphous, has been established on the basis of an X-ray investigation of a single crystal of the rubidium bronze.

The lattice of the hexagonal bronzes resembles those of the previously known tungsten bronze structures in that it contains fundamental structural elements of WO_6 octahedra, the oxygen atoms of which are common to two octahedra throughout. The accompanying diagram illustrates how the WO_6 octahedra are combined in this way to form a pattern of three- and six-membered rings extending in the *ab* plane. Slight displacements of the atomic positions cause the unit cell to comprise two such layers in the direction of the hexagonal axis. The alkali atoms are statistically distributed in the major interstices



Filled small circle, tungsten; medium circle, oxygen; large circle, alkali metal

of the lattice, thus co-ordinating twelve oxygen atoms. The theoretical upper limit of the alkali content evidently corresponds to a value of x of 1/3 in the formula given above.

The structure offers another example of the broad extent of the possible combinations of the WO_6 octahedra in tungsten–oxygen compounds, manifested in various tungsten oxides[2], tungsten bronzes[3], and heteropolytungstates[3]. Six-membered rings of WO_6 octahedra have previously been encountered only in the tungsten oxide $W_{18}O_{49}$, of complicated structure, where, however, they are arranged around empty channels of infinite extension running through the lattice[4].

Full details of this investigation will shortly appear elsewhere.

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Dec. 15.

[1] Magnéli, A., and Blomberg, B., *Acta Chem. Scand.*, **5**, 372 (1951).
[2] Magnéli, A., *Nova Acta Regiae Soc. Sci. Upsaliensis*, [4], **14**, No. 8 (1950).
[3] Wells, A. F., "Structural Inorganic Chemistry" (2nd edit., Oxford, 1950).
[4] Magnéli, A., *Arkiv Kemi*, **1**, 223 (1949).

Removal of Impurities from Tin by Vacuum Distillation

The low vapour pressure of tin at temperatures up to 1,000° C. makes it possible to remove more volatile constituents of tin-rich alloys by vacuum distillation. The use of this method has been described for the analytical determination of cadmium, tellurium, zinc, lead and phosphorus[1].

I have since used this procedure in attempts to remove the last traces of certain impurities from samples of refined tin. A specimen of tin was heated in an evacuated silica tube at 1,000° C. for four hours, after which a spectrographic examination showed arsenic, antimony, lead and bismuth to be absent. As there is some uncertainty as to the limits of spectrographic detection of these elements, a colorimetric method was used for the determination of arsenic, and this showed the arsenic content to be less than 0·0002 per cent. From this it seems that vacuum distillation is a promising method for the production of tin of very high purity.

In all the above work a pressure of about 0·05 mm. mercury was maintained during distillation by means of a rotary oil pump, and the evolved metal condensed in a ring on the cooler part of the silica tube. I have recently included a diffusion pump in the pumping circuit giving a pressure of about 10^{-5} mm. during distillation, and I have found that some separation of the evolved metal vapours can be obtained. In one experiment, three distinct bands condensed on the wall of the tube. These consisted of an outer black band mainly of antimony and an inner grey band mainly of tin, separated by a thin brown band, which has not yet been identified. This suggests a method for the separation and possible determination of trace impurities in tin. Work is continuing along these lines and will be reported elsewhere.

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Dec. 19.

[1] Price, J. W., *J. Soc. Chem. Indust.*, **44**, 283 (1945).

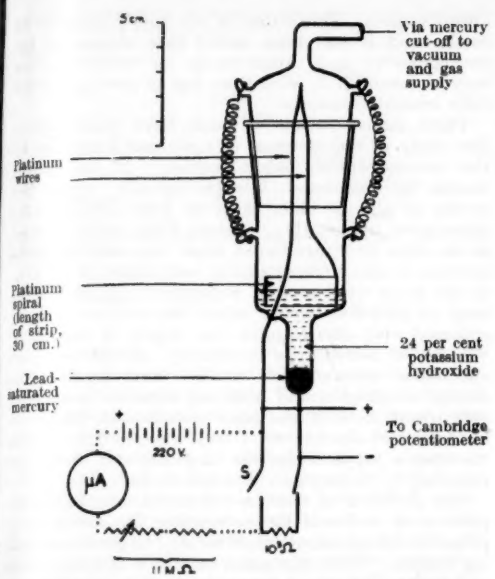
Galvanic Determination of Traces of Oxygen in Gases

The cathodic reduction of oxygen has been studied[1] in connexion with corrosion and air-depolarized galvanic cells; but so far no use seems to have been made of this process in gas analysis. I have experimented with cathodes half-immersed in the electrolyte under nitrogen and hydrogen and, with suitably designed cells, have found that otherwise difficultly detectable traces of oxygen in the gas phase, such as 10^{-6} c.c./c.c., were capable of giving substantial and easily measurable currents.

The diagram shows one of several types of cell tried as a 'reversed gas coulomb-meter'. The vessel is flushed by several evacuation-admission cycles. On closing the circuit over 1,000 ohms, there is at first a surge of current, owing to oxygen adsorbed on the platinum cathode. After this, if some 0·01 per cent oxygen is present, the current is limited by the depolarizing power of the cathode water-line. When about 0·001 per cent oxygen is present, or left, oxygen diffusion in the gas space takes over control and the current declines logarithmically.

To avoid plotting a curve and integrating, the current can be damped down to a chosen constant value, for example, 20 μamp., by using a high e.m.f. plus a high resistance in series with the cell. What is then relevant is the time required for the terminal voltage of the cell to be reversed in sign. This moment is sharply defined, though early warning is given of its approach. The auxiliary part of the circuit is then shorted out by closing the switch S, so that the current is allowed to decline. Otherwise plumbite and later water would be reduced along with oxygen. No further observations are, however, necessary if the 'tail', $\int_{i=20}^{i=0} i\,dt$, that is, the residual oxygen, has been determined in one previous run, as an apparatus constant.

On introducing measured traces of air, the number of coulombs obtained on discharge has been compared with that calculated from Faraday's law, assuming reduction of oxygen to hydroxyl. The measured results are some 5 per cent lower than the calculated figure, possibly owing to some oxygen being reduced only to hydroperoxyl. With the cell described, oxygen



in high-purity nitrogen (< 0·001 per cent oxygen) can be quickly determined, with an uncertainty of about 0·00005 per cent. No calibration with known gases is required. The range is not limited by the method itself but only by the imperfections of valves and connexions.

I wish to thank the Mond Nickel Co., Ltd., for permission to publish this communication.

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Dec. 6.

[1] Heise and Schumacher, *Trans. Elect. Chem. Soc.*, **62**, 383 (1932). Thornhill and Evans, *J. Chem. Soc.*, 2109 (1938). Beri, *Trans. Elect. Chem. Soc.*, **83**, 253 (1943). Weisz and Jaffe, *Trans. Elect. Chem. Soc.*, **93**, 128 (1948). Jofa, Shimshelevitch and Andereva, *J. Phys. Chem. U.S.S.R.*, **23**, 828 (1949). Bagotskii and Motov, *Dok. Ak. Nauk.*, **71**, (3), 501 (1950). Delahay, *J. Elect. Chem. Soc.*, **97**, 198 (1950). Patrick and Wagner, *Corrosion*, **6**, 34 (1950). Shigeru Mizuno, *Chem. Abstr.*, 5233e, 6305d, 10549i (1950). Tödt, *Z. Elek. Chemie*, **54**, 485 (1950). Grubitsch, *Werkstoffe und Korrosion*, **2**, 85 (1950).

Anomalous Adsorption of Nitrogen at 90° K.

In recent communications in *Nature*[1], the hundred-fold discrepancy between two methods of estimating the surface area of coals was discussed; I put forward the view that the low-temperature adsorption of nitrogen under-estimated the area very considerably, and made the suggestion that, since the pore constrictions of coals at ordinary temperatures are comparable with molecular dimensions, the anomaly might arise from a reduced accessibility of the internal surface at liquid-air temperatures.

Should this be so, adsorption of nitrogen at higher temperatures might well be increased because of the increased accessibility, although this increase would be offset by the normal reduction of adsorption as given by the Clapeyron–Clausius equation; in favourable cases a reversal of the usual effect of temperature on adsorption might be observed. From the published results[1,2], it is clear that the effect should occur between 90° and 300° K., and measurements have therefore been made in this range.

The following experiments were made with a Scottish household coal (coal *A*) having a heat of wetting in methanol of 11·0 cal.gm.$^{-1}$, and of the following analysis: C, 82·0; H, 4·8; N, 1·7; O + errors, 11·5 (dry, mineral-free basis); ash, 1·9 per cent. The adsorbate, oxygen-free nitrogen, was carefully dried and the coal (through 72 B.S.S.) was thoroughly outgassed at 110° C. Adsorption of nitrogen at atmospheric pressure gave 1·36 per cent by weight at 90° K. and 0·96 per cent at 195° K. This small change in the adsorption for a two-fold increase in temperature is in harmony with expectations, and for a fuller comparison of the adsorption at different temperatures measurements were made at several pressures (between 4 and 76 cm. mercury) and at four temperatures. The apparent isosteric heats of adsorption were then calculated. These are given in the accompanying table.

Temp. of isotherm pairs (° K.)	Range of apparent isosteric heats of adsorption (cal.mole^{-1})	Range of nitrogen adsorptions (per cent by weight)
90–195	2,0–600	0·40–0·85
195–218	1,800–2,200	0·40–0·70
273–293	1,500–3,300	0·07–0·25

Slow rates of adsorption were encountered and readings were taken after half an hour (cf. Malherbe[2], who made readings after 10 min.; apparent heats of adsorption calculated from the adsorption after 10 min. lay in the same ranges as those from half-hour readings). That adsorption was physical was demonstrated by the ease with which nitrogen was completely desorbed by pumping on the rotary pump only.

It is clear from these results that adsorption at room temperatures is normal, since $-\Delta H$ lies in the range associated with the adsorption of nitrogen on other carbonaceous solids (including adsorption at liquid nitrogen temperature). The small dependence upon temperature reflected in the low value of the apparent heat of adsorption calculated from the 90° and 195° K. isotherms may be attributed to the sub-normal adsorption at 90° K., which is accounted for by the suggested decreased accessibility of the surface at low temperatures. It would also appear, from the normal values of the heat of adsorption given by the 195° and 218° K. isotherms, that the change takes place at temperatures below 195° K.

The coal used in these experiments possessed a comparatively open structure (judged from the heat of wetting[3]). Striking results were obtained using a coal of a more compacted structure, namely, a coking coal (coal *B*) having a methanol heat of wetting of 4·9 cal.gm.$^{-1}$ and the following analysis: C, 84·5; H, 5·4; N, 2·0; O + errors, 8·1 (dry, mineral-free basis); ash, 4·7 per cent.

Nitrogen was first adsorbed on the coal at 90° K., and, in contrast with adsorption on coal *A*, equilibrium was reached within 15 min. at a pressure of 35·6 cm. mercury. The liquid-oxygen bath was then quickly replaced by a carbon dioxide bath (195° K.), when the pressure immediately rose rapidly to an extent corresponding exactly to the rise in temperature of the gas in the dead-space (that is, no desorption occurred), but thereafter steadily *decreased* to an equilibrium value of 43·0 cm. mercury; this re-adsorption is attributed to the new adsorbing surface (not available at 90° K.).

On now reducing the temperature of the adsorbent to 90° K., equilibrium was established, but this time at a pressure of 28·6 cm. mercury. The gas adsorbed on the new surface at the higher temperature had clearly been trapped by the change induced in the coal structure by the reduced temperature. The equilibrium pressure values of 43·0 cm. at 195° K. and 28·6 cm. at 90° K. were afterwards reproduced by changing the temperature of the adsorbent without allowing the adsorbent temperature to rise above 195° K. No permanent structural change is incurred by the coal, since after allowing it to attain room temperature and repeating the sequence of operations at a different initial pressure, the same effects were reproduced.

The observations on these two coals confirm the suggestion of previous communications that the adsorption of nitrogen on coals at liquid-air temperatures gives values for the surface area which are considerably in error. While the precise mechanism through which much of the internal surface area is made inaccessible to nitrogen is not known, the difference in the rates of adsorption on the two contrasting coals agrees with the tentative conclusions drawn from the structural model for coals which has previously been put forward[3]. It seems that at 90° K. the pore constrictions of coal *A* are reduced, giving slow adsorption of nitrogen. The constrictions of the more compacted structure of coal *B*, however, become impenetrable to the nitrogen molecule at 90° K., while at 195° K. the constrictions are large enough to permit a greater adsorption.

I am indebted to the British Coal Utilisation Research Association for the analysis of the coals and for determinations of heat of wetting.

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Nov. 29.

[1] Dryden, I. G. C., *Nature* [169, 269 (1952)]. Maggs, F. A. P., *Nature*, [169, 269 (1952)]. Lecky, J. A., Hall, W. K., and Anderson, R. B., *Nature*, 168, 124 (1951).
[2] Malherbe, P. le R., *Fuel*, 30, 97 (1951).
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Use of Unweaned White Mice in Foot-and-Mouth Disease Research

It is now two years since it was found that an acute clinical infection could be readily produced by foot-and-mouth disease virus when inoculated intraperitoneally into mice one week old. A summary of the first year's work was published a year ago[1]. We have continued to use large numbers of unweaned mice in our work and we have encouraged their use in other institutes engaged on foot-and-mouth disease research. The early indications that we had of the value of this animal have been fully confirmed, and corroborative reports are now being received from other workers. It would be appropriate, therefore, to summarize some of our more recent findings.

In comparative infectivity titrations in cattle by intradermal inoculation of the tongue and in mice by intraperitoneal inoculation, the 50 per cent positive end-points have been the same in both species for seven of eight cattle strains, including five of recent field origin. Similar results have also been obtained with culture-passaged virus of three of these strains. A preparation of the eighth strain used in these titrations had an end-point a hundred-fold lower in mice. This strain is not highly invasive for cattle, and it has been noted that strains of low pathogenicity and invasiveness for cattle are less easy to establish in mice than highly pathogenic and fully invasive strains.

Three mouse strains of virus have been used in the study of transference of maternal immunity by the non-susceptible adult mouse. If the female mouse is inoculated intraperitoneally when five weeks of age or older with at least 10^4–10^6 ID_{50} (unweaned mouse ID_{50}), litters born, even as soon as six days later, are found when one week old to be immune to the intraperitoneal inoculation of 10^3 ID_{50} of the same virus strain. Subsequent litters born as long as fifty-five weeks after the mother was inoculated may also acquire this degree of immunity. We have tested the immunity of litters from vaccinated female mice to determine whether the results obtained would bear any relation to those of concurrent tests of the same vaccines in cattle. A limitation to the success of such a method for testing vaccines is, apparently, the large amount of antigen required to immunize the adult mouse.

The inclusion of tests in unweaned mice in a comparison of methods for estimating the neutralizing power of convalescent cattle serum has given interesting results. When the same mixtures of cattle virus and serial dilutions of serum are used in parallel tests in cattle and mice by intradermal inoculation of the tongue and intraperitoneal inoculation respectively, the antibody titre indicated by the mouse test is higher than by the cattle test. Thus a 1 in 20 dilution may be the lowest concentration of serum which will neutralize a given dose of virus in cattle, whereas in mice a 1 in 2,000 dilution will suffice although the control titres of virus are the same in the two species. Similar results were obtained in parallel tests in guinea pigs inoculated intradermally in the metatarsal pads and in unweaned mice inoculated intraperitoneally using a guinea pig adapted strain of virus. A higher antibody titre was recorded in the mouse test.

The use of unweaned mice in serum neutralization tests has the great advantage of providing the multiplicity of observations required much more economically than cattle, and the wide application of these tests in both the study of the immune response and the detection of antigenic differences between strains is therefore facilitated. The mouse test has proved to be suitable for the demonstration of an increasing antibody concentration in cattle sera beginning four days after the first appearance of lesions of foot-and-mouth disease. An epizootiological application of these studies has been to determine the type of virus responsible for a field outbreak in Great Britain in which the lesions, though recent, had passed beyond the phase suitable for provision of antigen for routine complement-fixation tests. Serum from the affected cattle gave negative results in complement-fixation tests; but the presence of specific antibody was detected by neutralization tests in mice.

The results obtained in studies of antigenic differences between two strains of Waldmann *C* type are illustrated in the accompanying table. The result of the test in mice confirms the existence of the difference between the two strains demonstrated in the cattle test and by complement fixation, and indicates the potential usefulness of the new test in this sphere.

The carcasses of infected mice, except the head, skin and viscera, have been used as a source of virus

ANTIGENIC DIFFERENCES BETWEEN WALDMANN *C* TYPE FOOT-AND-MOUTH DISEASE VIRUS STRAINS 149 AND 733

(*a*) Neutralization titres of strain-specific cattle sera.

(i) In mouse tests

		Mouse virus	
		149 (630 ID_{50})	733 (630 ID_{50})
Cattle	149	1/460	1/11
Serum	733	1/190	1/49

(ii) In cattle tests.

		Cattle virus	
		149 (32 ID_{50})	733 (50 ID_{50})
Cattle	149	1/44	1/5·7
Serum	733	1/37	1/22

(*b*) Log dose of complement fixed by cattle virus and guinea pig strain specific sera.

		Virus	
		149	733
Serum	149	0·26	0·08
	733	0·06	0·37

for preparation of the formalinized aluminium hydroxide type of foot-and-mouth disease vaccine. Such a vaccine prepared using tissue of the thirteenth mouse passage of strain 119, Vallée *A* type, was tested in cattle in 100-, 30- and 10-ml. doses. Two and a half weeks after vaccination three groups of eight vaccinated cattle and a group of eight unvaccinated control animals were inoculated intradermally into the tongue at each of ten sites with 10^4 ID_{50} of strain 119 cattle-passaged virus. In the 100-ml. group, eight out of eight cattle were protected against the development of secondary lesions, which corresponds to complete protection of the animal against infection by contact—three cattle, in fact, showed no primary reaction; in the 30-ml. group, five out of eight were similarly protected, and in the 10-ml. group, four out of eight were protected; the eight control cattle reacted with extensive primary lesions and with secondary lesions on all four feet. The 50 per cent protection dose of this vaccine under the conditions of test was 15 ml., which corresponded to an original virus content of $10^{5\cdot9}$ ID_{50} (cattle tongue ID_{50}) and to a mouse tissue content of 0·2 gm.; week-old mice each provide about 1 gm. of suitable tissue. The original virus content required for the 50 per cent protection dose of this type of vaccine prepared from cattle virus of this strain is $10^{6\cdot8}$ ID_{50}. The significance of this apparently better protection, judged by the original virus content of the vaccine, is being further investigated. The titre of the filtrate of mouse tissue used to prepare this strain 119 vaccine was lower than that found for similar preparations of other strains, so it may be possible with more infective preparations to prepare mouse tissue vaccines of even higher immunizing potency.

Experience with six virus strains in unweaned white rats has indicated that these animals show early resistance but are highly susceptible to infection by inoculation during the first thirty-six hours of life. The signs of infection are similar to those seen in the mouse, and the incubation period may be as short as one day. The tissues are of high titre and the yield is about three times that from a 7–10 day-old mouse. The suitability of rat tissue for vaccine preparation is at present being investigated.

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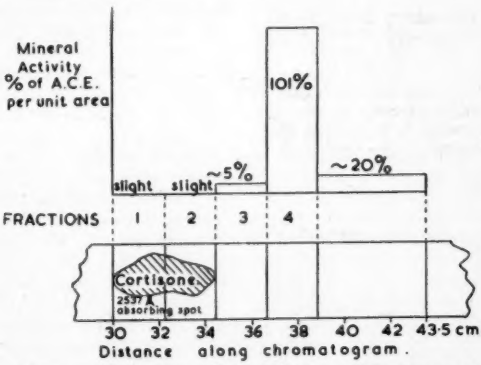
Isolation of a Highly Active Mineralocorticoid from Beef Adrenal Extract

Grundy, Simpson and Tait[1] have shown that most of the activity of beef adrenal extract, as measured by its effect on the mineral metabolism of adrenalectomized rats[2], was coincident with 11-dehydro-17-hydroxy-corticosterone (cortisone), when the extract was fractionated by Zaffaroni's method of paper chromatography[3]. From quantitative measurements of the biological activity of the fraction, it was concluded that the activity was due to the presence of a compound other than cortisone.

Further work has shown that the activity can be completely separated from cortisone by running the fraction previously isolated for much longer distances along the chromatogram. The accompanying diagram shows the distribution of activity along a typical chromatogram compared with the position of cortisone as indicated by the area of extinction of ultra-violet radiation of wave-length 2537 A. The absorption of such radiation is a particularly sensitive indication ($> 0{\cdot}5$ μgm. per sq. cm.[2]) of the presence of cortisone and other 3α,β unsaturated keto-steroids ($\lambda_{max.} \sim$ 2400 A., log $\varepsilon \sim 4$)[4]. Fractions 1 and 2, which contained all the cortisone, had little effect on mineral metabolism. Fraction 4, which contained nearly all the activity, was eluted and its absorption spectrum determined in ethyl alcohol solution. This showed no absorption peak or inflexion in the region of 2400 A., whereas 0·5 per cent of fraction 1 or 2 gave a distinct peak. As the detection method described below showed the presence of the active compound in an appreciable amount, the absence of a peak indicated that the compound itself was not a 3α,β unsaturated ketonic steroid.



Figures on blocks show total activity in each fraction as a percentage of total cortical extract activity. In the same time, Kendall's compound *F* moved 12 cm. and Reichstein's compound *S* would have moved 150 cm.

Fraction 4 gave a positive reaction with triphenyl tetrazolium chloride, which for cortical steroids indicates the presence of an α-ketol grouping in the 20,21 position[5]. Assuming that the compound giving this reaction was the active mineralocorticoid and that its action on the reagent was equivalent to that of the cortical steroids with the α-ketol grouping, then the mineral activity of the compound was calculated to be of the order of twenty times that of deoxycorticosterone on an equimolar basis.

Most cortical steroids have been shown to run in a definite and constant sequence in paper chromatographic systems, using untreated filter paper with a polar solvent as the stationary, and a non-polar

solvent as the mobile, phase[6,7]. Zaffaroni has observed that the rate of running of the steroids is closely related to the number and nature of groups containing oxygen in the molecule[4]. We have found that the hydrophilic nature of the molecule can be approximately described by the expression

$$z = 2{\cdot}5x_3 + 1{\cdot}5x_{17} + x_{11},$$

where $x = 1$ for =O and 3/2 for OH groupings, the subscript number that describes x referring to the position of the substitution of these groupings. This expression holds for compounds possessing typical cortical steroid substitutions, including the α-ketol grouping at the 20,21 position. The rate of running of the steroids is given by a function of z, the particular form of which is determined by the actual solvents used. However, for any system, the comparison of the values of z between different steroids gives their sequence; for example, Reichstein's S (Δ^4 pregnane 17,21 diol 3,20 dione, $z = 4{\cdot}75$), Kendall's E (Δ^4 pregnane 17,21 diol 3,11,20 trione, $z = 5{\cdot}75$), and Kendall's F (Δ^4 pregnane 11,17,21 triol 3,20 dione, $z = 6{\cdot}25$) move in the sequence of their z values, F moving the slowest. The active mineralocorticoid runs slightly faster than Kendall's compound E and much slower than Reichstein's compound S; it must therefore have a z value between 5·75 and 4·75. These requirements are not fulfilled by substitutions at the 11 and 17 positions only, and together with the ultra-violet spectroscopic evidence indicate the presence of an OH group in the 3 position. This is further indicated by the active compound forming a di- or poly-acetate on acetylation.

Of the twenty-eight steroids isolated from the adrenal cortex only two, Reichstein's compound P (allopregnane 3,17,21 triol 20-one, $z = 6{\cdot}00$), and R (allopregnane 3,11,21 triol 20-one, $z = 5{\cdot}25$) nearly satisfy the required z values, have an α-ketol grouping at the 20,21 position and yet are not 3-keto compounds. Zaffaroni has observed that Reichstein's P moves slightly more slowly than Kendall's E. We have confirmed this in adrenal extract using the detection method of R. Neher and A. Wettstein[8] for 11-deoxy compounds. It would seem, therefore, that, of the known cortical steroids, only Reichstein's compound R (allopregnane 3β,11,21 triol 20-one) could be the active compound. There is some evidence that epimers of the same compound run at slightly different rates; for example, Reichstein's C (allopregnane 3α,11,17,21 tetrol 20-one) runs slightly faster than Reichstein's V (allopregnane 3β,11,17,21 tetrol 20-one). There is, therefore, a further possibility that the active compound is an epimer of Reichstein's R or P.

This further investigation has fully confirmed the earlier, more indirect work[1,2], which showed that the mineral activity of beef adrenal extract was not due to any of the known biologically active cortical steroids. Positive characterization of the structure of the compound must await the isolation of larger amounts of material; but it seems certain that this compound does not possess the 3α,β unsaturated ketonic grouping which has previously been assumed to be essential for high activity in mineral metabolism.

We wish to thank Allen and Hanburys for supplies of their adrenal extract 'Eucortone' and Prof. T. Reichstein for gifts of steroids. We have had the advantage of many discussions with Drs. Kellie and Jepson of this Medical School, and we are also grateful to Profs. E. C. Dodds and J. E. Roberts for their constant interest and advice. P. Avivi, S. Graves and M. Woodford gave us invaluable experimental assistance.

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Separation of Urinary Œstrogens by Micro-Partition Chromatography

In a recent report elsewhere[1] we have shown that the œstrone and œstradiol in the phenolic fraction of urinary extracts can be separated satisfactorily, in microgram quantities, by means of a silica column, using aqueous sodium hydroxide as the stationary phase and benzene as the moving phase. We were at that time unable to deal with the œstriol fraction chromatographically, and separated it chemically by the method of Bachman and Petit[2]; this, however, was a tedious process and left unsolved the problem of purification so essential for satisfactory determination by fluorimetry using phosphoric acid. We have now succeeded in overcoming both these difficulties in one operation, and can separate the three fractions from the crude phenolic extract, achieving a satisfactory degree of purification in the process, on a single silica column.

As before, the column consists of 1·25 gm. of 'Celite 535' (Johns Manville Co., Ltd.), previously washed with a mixture of chloroform and butanol (3 : 1). The stationary phase is 2·3 N sodium hydroxide (1 ml.). Equilibrated benzene is run through under pressure to separate the œstrone and œstradiol as previously described. When the last of the moving phase has reached the top of the 'Celite' column, the pressure is let down and the vessel originally containing the phenolic extract is washed with four lots of 0·5 ml. of chloroform–butanol mixture (3 : 1), previously equilibrated with 2·3 N sodium hydroxide, so as to take up any œstriol which may not have dissolved in the benzene. The pooled chloroform-butanol washings are then added to the top of the column and forced through, followed by a further 2 ml. of chloroform–butanol mixture to wash down the sides of the tube holding the column. Finally, the rest of the new moving phase (originally 55 ml.) is passed through the column. Our fraction cutter produces fractions of 4·2 ml., and we find the œstriol to be in fractions 3–7 of the 'second run'.

Further details of the method, and the results obtained with it, will be published elsewhere.

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Effect of Trichloracetic Acid on Adrenaline Chromatograms

EXTRACTS free from blood and protein are readily prepared for biological estimation by grinding suprarenal glands with 5 or 10 per cent aqueous trichloracetic acid and centrifuging. However, on submitting such an extract from a cat to paper-partition chromatography using as solvent butanol : acetic acid : water (4 : 1 : 5), we observed that development with aqueous potassium iodate[1] gave three spots. Two of these corresponded to adrenaline and *nor*adrenaline (R_F = 0·32 and 0·25, respectively) and the third to an unknown adrenaline-like substance (R_F = 0·63). Three spots were also detected when development was carried out with the Pauly diazo-reagent or potassium ferricyanide (*p*H 7·8).

Further investigation showed that, when 0·03 ml. (30 μgm.) of pure *l*-adrenaline in 5 per cent aqueous trichloracetic acid was chromatographed as above, two spots were observed having R_F values of 0·32 and 0·63, respectively. Removal of excess trichloracetic acid from the solution by ether extraction prior to chromatography did not prevent the appearance of the additional spot.

That the effect was due entirely to the presence of trichloracetic acid was shown by passing the solution through a column of the anion exchange resin, 'Amberlite 1RA-400', in the chloride form. The filtrate, which now contained adrenaline in approximately *N*/3 hydrochloric acid, gave only the single adrenaline spot when chromatographed. This spot was equal in intensity to that obtained from a control solution of adrenaline (at the same concentration) in *N*/3 hydrochloric acid, and biological tests on the cat's blood pressure confirmed that passage of the trichloracetic acid solution through the resin resulted in little or no loss of activity. The accompanying photograph (Fig. 1) shows the chromatogram given by these solutions. When the areas corresponding to the two spots in chromatogram *B* were eluted with 0·01 *N* hydrochloric acid, biological tests showed that the total activity was almost equally divided between the two spots.

The formation of two spots was similarly observed with trichloracetic acid solutions of the following adrenaline-like compounds: 3-hydroxytyramine, epinine, corbasil, α-ethyl*nor*adrenaline, N-ethyl*nor*-

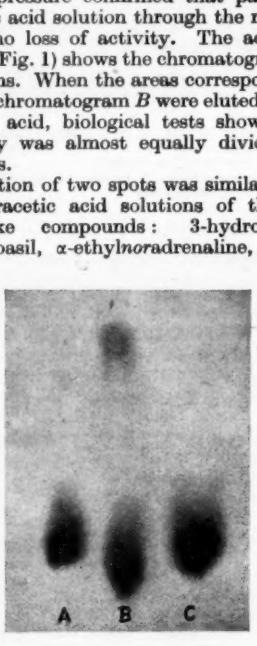

Fig. 1. (*A*) Solution of adrenaline (30 μgm.) in 5 per cent trichloracetic acid after passage through 'Amberlite 1RA-400' (chloride form). (*B*) Solution of adrenaline (30 μgm.) in 5 per cent trichloracetic acid before passage through 'Amberlite 1RA-400' (chloride form). (*C*) Solution of adrenaline (30 μgm.) in *N*/3 hydrochloric acid for comparison with (*A*)

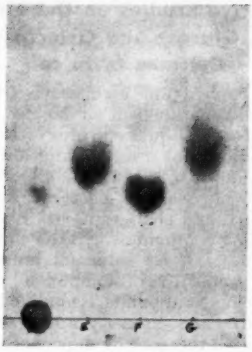

Fig. 2. (*D*) Adrenaline (30 μgm.) in *N*/3 hydrochloric acid dried at 100° C. before chromatography. (*E*) Adrenaline (30 μgm.) in 0·01 *N* hydrochloric acid dried at 100° C. before chromatography. (*F*) As *D*, dried at 15° C. (*G*) As *E*, dried at 15° C.

adrenaline, N-*iso*propyl*nor*adrenaline and adrenalone. On the other hand, *nor*adrenaline and 3.4-dihydroxyphenylalanine each produced only one spot under the same conditions.

Recently, Crawford[2] showed that adrenaline and *nor*adrenaline may, under certain conditions, react with lactic acid yielding lactyl derivatives by esterification of their side-chain hydroxyl group; the resulting solutions produced two spots when chromatographed in phenol–water or butanol–hydrochloric acid. However, the fact that in our experiments two spots were obtained with adrenalone, 3-hydroxytyramine and epinine (compounds having no hydroxyl group in the side-chain) indicated that the phenomenon did not arise by formation of a trichloracetic ester.

A possible explanation is furnished by the work of Kendall[3], who showed that weakly acid phenols can form rather unstable compounds with trichloracetic acid ($K = 2 \times 10^{-1}$) and with picric acid ($K = 1{\cdot}6 \times 10^{-1}$). Thus, the additional spot observed in our chromatograms may be due to such a compound of adrenaline with trichloracetic acid. That solutions of adrenaline in 5 per cent methanolic picric acid were also found to give two spots when chromatographed lends support to this view. Two spots have not been observed on chromatographing solutions of adrenaline in 5 per cent aqueous oxalic acid ($K = 6{\cdot}5 \times 10^{-2}$), but this acid was not studied by Kendall.

In the course of the above experiments two further phenomena were observed: (1) retardation of the spots when the adrenaline solution was prepared in *N*/3 instead of 0·01 *N* hydrochloric acid, and (2) retention of material at the starting-line when the applied spots were dried at elevated temperature prior to chromatography. These points are illustrated in Fig. 2.

The above results emphasize the need for great care in the preparation and interpretation of chromatograms of adrenaline-like compounds in tissue extracts.

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Comparative Studies on the Metabolism of Lactose, Glucose and Galactose in Liquid Cultures of *E. coli*

We have carried out comparative investigations concerning the metabolism of lactose and its constituent monoses in liquid cultures of *E. coli*. Koser's synthetic medium was used. Samples were evaluated after incubation of 0, 6, 12, 24, 48, 72 and 96 hr. at 37° C., for increase of bacterial mass (nephelometrically), *p*H, and changes in the medium concerning the reducing compounds. In the chromatographic technique we used, as solvents, butanol–pyridine–water in the proportion of 45 : 25 : 40. To reveal the spots of reducing compounds, a modified silver nitrate test was used. The intensity and size of the spots developed were a measure of the concentration of the substrates in the medium.

We find that (1) lactose is split more slowly than its constituent monoses; (2) stabilization of the *p*H between 7·0–8·0 during incubation accelerates the lactose metabolism.

Experimental. Lactose metabolism was more strongly inhibited by 0·05 *M* sodium fluoride than that of glucose. 0·1 *M* Sodium fluoride inhibited completely the metabolism of the substrates. Intermediate metabolites with reducing effect were not found. 0·0035 *M*, 0·008 *M* and 0·012 *M* phloridzin did not inhibit carbohydrate metabolism.

0·0025 *M* Monoiodoacetate inhibited completely the breakdown of lactose, probably at the first metabolic stage. The breakdown of glucose was also inhibited but at a later stage, as was shown by the appearance of an intermediate metabolite (Fig. 1).

With sodium selenite (0·001 *M*), lactose metabolism was less inhibited than in analogous experiments with monoiodoacetate. Under the same experimental conditions with glucose, glycolysis was partially inhibited and there appeared constantly an intermediate metabolite. Its appearance on chromatograms and R_F values were identical with the metabolite obtained by iodoacetate poison. In selenium tests the concentration of metabolite was lower than in tests with monoiodoacetate (Fig. 3).

In our comparative studies we have also tried to reactivate blocked enzymatic systems. For systems blocked with fluoride we employed increased quantities of magnesium or manganese ions respectively. Reactivation was not achieved, for the increased quantities of magnesium and manganese had an inhibitory effect on the carbohydrate metabolism.

Attempts to reactivate enzymatic systems blocked by inhibitors of the thiol groups (monoiodoacetate, selenite) were made by use of cysteine in 0·005 *M* concentration. By use of cysteine a complete reactivation was obtained of the enzymatic system poisoned with selenite for six hours (Fig. 3). On the other hand, in monoiodoacetate poisoning we were unable to observe reactivation. Only with simultaneous introduction of an inhibitor with excess of cysteine was the substrate metabolism normal. We tried also to activate pyruvic oxidase using thiamine and calcium pantothenate. The experiments showed that thiamine has no influence on the metabolism of the substrates, or on the splitting of the intermediate metabolite. Calcium pantothenate, on the contrary, distinctly accelerated the breakdown of glucose at the preceding stage of intermediate metabolite. There appeared in these circumstances on the chromatograms an intense accumulation of the metabolite (Figs. 2 and 3). The splitting of lactose was accelerated by calcium pantothenate itself, although it had no visible influence in the presence of the above-mentioned inhibitors.

In experiments in the presence of arsenines at a concentration of 0·005 *M* and of selenite at a concentration of 0·001 *M*, the inhibiting effects of the two factors were additive (Fig. 3). Arsenine alone, as an inhibitor of thiol groups, slowed up the meta-

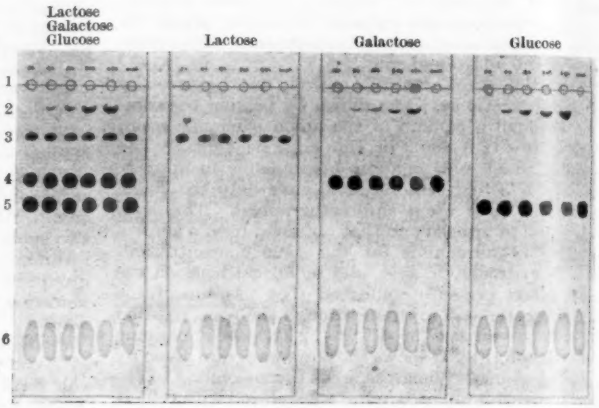

Fig. 1. Effect of iodoacetate ($2·5 \times 10^{-3}$ *M*) on carbohydrate metabolism of *E. coli*. Solvent system : *n*-butanol–pyridine–water (45 : 25 : 40). Spraying reagent : silver nitrate (modified method).
1, Starting line ; 2, unidentified metabolite ; 3, lactose ; 4, galactose ; 5, glucose ; 6, iodoacetate

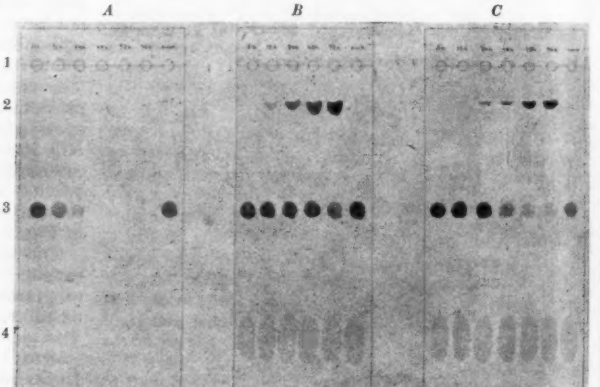

Fig. 2. Effect of pantothenate (5×10^{-3} *M*) in presence of iodoacetate on glucose metabolism of *E. coli*. Solvent system : *n*-butanol–pyridine–water (45 : 25 : 40) Spraying reagent : silver nitrate (modified method).
A, Glucose + pantothenate ; *B*, glucose + pantothenate + iodoacetate (simultaneously added) ; *C*, glucose + iodoacetate + pantothenate (added after 48 hours).
1, Starting line ; 2, unidentified metabolite ; 3, glucose ; 4, iodoacetate

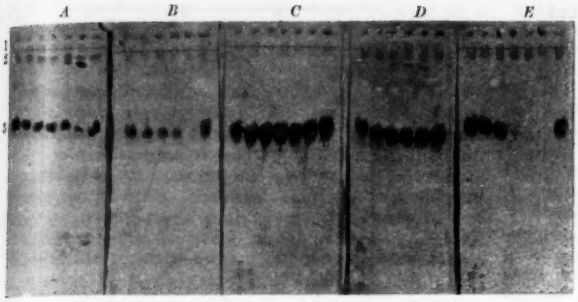

Fig. 3. Solvent system : *n*-butanol–pyridine–water (45 : 25 : 40). Spraying reagent : silver nitrate (modified method).

A, Glucose + selenite (1×10^{-2} *M*) + pantothenate ; *B*, glucose + arsenite ; *C*, glucose + selenite + arsenite ; *D*, glucose + selenite ; *E*, glucose + selenite + cysteine.

1, Starting line ; 2, unidentified metabolite ; 3, glucose

bolism of glucose and inhibited completely the metabolism of lactose.

Investigations on the nature of the intermediate metabolite will be the subject of a further communication.

Thus experiments using inhibitors show that enzymes catalysing the first stage of lactose metabolism of *E. coli* (1) contain active sulphydryl groups ; and (2) are more sensitive to the influence of all the inhibitors employed by us than enzymes catalysing glycolysis. This work emphasizes the importance of paper chromatography for studies of metabolism.

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Optimum *p*H and Iodine Absorption of an Enzyme Molecule

In a previous communication it has been shown by Basu and Nandi[1] that the extent of inactivation consequent on the unfolding of the protein chain of an enzyme molecule could be detected by iodimetric titration of the SH-groups uncovered by the unfolding of the coiled-up molecules. In this connexion it has been noted that increase in iodine absorption occurs in cases where the enzyme has been partially deactivated, although no denatured, insoluble protein was formed. It may be concluded, therefore, that denaturation leading to insolubilization takes place only when the unfolding of the protein coil has proceeded to an appreciable extent, whereas deactivation makes its appearance much earlier and with a lesser degree of uncoiling. These observations suggest that the variation in the extent of enzyme activity at different *p*H's may, to some extent, depend on the extent of coiling or uncoiling of the enzyme molecule. In order to test this point, pepsin solution was adjusted to different *p*H's by the addition of the necessary amount of hydrochloric acid or sodium hydroxide as the case may be, and titrated with $N/2{,}000$ iodine solution below 15° C., using starch as indicator. The results are shown in Table 1.

Table 1. Iodine Absorption by Pepsin at Different *p*H's (*p*H adjusted by the addition of 0·1 *N* hydrochloric acid or 0·1 *N* sodium hydroxide to 5 per cent pepsin solution of initial *p*H 5·8)

*p*H	Iodine (gm.)/gm. enzyme × 10^4
2·20	0·3241
3·00	0·3831
3·95	0·4715
5·80	0·6365
7·85	7·6718
8·50	0·7366
9·55	0·9724

It may be observed from this table that at about *p*H 2 the pepsin has got the lowest iodine absorption value, a *p*H at which the activity of this enzyme is maximum. Now it has been shown[1] that minimum iodine absorption value is associated with maximum tightness of coiling, and so the optimum *p*H is associated with maximum coiling of the pepsin molecule. As the *p*H is increased, the iodine absorption value increases, which is also parallel to increased uncoiling or diminished activity.

When we consider the case of trypsin, an exactly similar conclusion is reached. From Table 2 it is to be noted that iodine absorption is minimum at about *p*H 8, which also corresponds to maximum activity range, whereas at lower *p*H values the iodine absorption is higher, corresponding to lesser activity of trypsin.

Table 2. Iodine Absorption by Trypsin at Different *p*H's (*p*H adjusted by the addition of 0·1 *N* hydrochloric acid or 0·1 *N* sodium hydroxide to 3·2 per cent trypsin solution of initial *p*H 4·8)

*p*H	Iodine (gm.)/gm. enzyme × 10^4
1·1	2·65
1·9	2·27
3·5	1·88
5·4	1·80
6·7	1·49
8·0	1·33
8·2	1·41
8·5	1·41
10·0	1·72

From these two sets of results, it is therefore evident that, at least in the case of pepsin and trypsin, the *p*H optima is associated with maximum compactness of the coiled-up structure of the protein molecule. It is difficult to account for this variation in the extent of folding of the enzyme molecule at different *p*H's, but in all probability it may be ascribed to the formation of salt with either NH_2- or COOH-groups (whichever is predominant) of the molecule, electrolytic dissociation of the salts, and mutual repulsion between the similarly charged COO^-- or NH_3^+-groups on the same molecule with the consequent unfolding of the protein molecule.

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Acetylcholinesterase in Thrombocytes

It has been shown recently[1] that the thrombocytes of rat blood contain a cholinesterase having properties similar to the acetylcholinesterase found in erythrocytes. The present communication gives evidence for the presence of an acetylcholinesterase in the thrombocytes of other animals.

The thrombocytes were isolated from the blood of different animals[1], washed twice in saline solution, and then suspended in a suitable volume of distilled water. The cholinesterase activity of these suspensions was determined manometrically in the Warburg apparatus with acetylcholine and butyrylcholine as substrates. The results are recorded in the accompanying table.

Hydrolysis of Acetylcholine and Butyrylcholine by Thrombocytes

Esterase activity (b_{38}) expressed in μl. carbon dioxide evolved in 30 min. from a bicarbonate solution. 0·4 ml. of the thrombocyte preparation and 1·6 ml. of the substrate solution. Citrate blood, unless otherwise stated

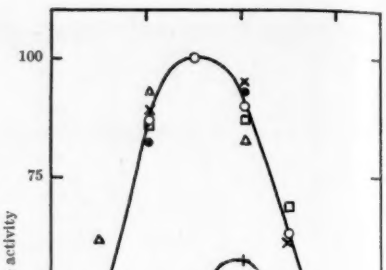
Animal	b_{38}		b_{38}
	acetylcholine $3{\cdot}30 \times 10^{-3}$ *M*	butyrylcholine $9{\cdot}54 \times 10^{-4}$ *M*	acetylcholine per 100 mgm. dry weight
Rat ♂ (heparin blood)	89·5	18	9,320
Rat ♂ (citrate blood)	52	11·5	—
Rat ♀	98·5	4	10,250
Cat ♀	225	4·5	22,800
Rabbit	66	14·5	17,000
Dog	54·5	16·5	3,630
Horse	91	3	9,100

Cat and rabbit thrombocytes show a significantly higher esterase activity than rat thrombocytes. Acetylcholine is split at a much higher rate than butyrylcholine. This is one of the characteristics of an acetylcholinesterase, that is, the type of acetylcholine-splitting enzymes known to occur chiefly in nervous tissues, electric organs, and erythrocytes[2].

A further characteristic feature of acetylcholinesterase is that its activity is depressed when the acetylcholine concentration is higher than 3×10^{-3} *M*. The relationship between the esterase activity of thrombocytes and acetylcholine concentration is shown in the accompanying graph (upper curve). An almost symmetrical bell-shaped curve is obtained when the esterase activity is plotted against the negative logarithm of the substrate concentration (*pS*). The optimum acetylcholine concentration is the same for all thrombocyte preparations studied and corresponds to that found for the acetylcholinesterase from other sources[2]. The lower curve in the graph shows that choline inhibits the activity and the optimum substrate concentration is shifted to a higher level.

Tributyrin and benzoylcholine are not hydrolysed; but acetyl-β-methylcholine is split at a relatively high rate. Specific inhibitors of acetylcholine-splitting enzymes also inhibit the thrombocyte esterase. Thus, for example, the I_{50} value (molar inhibitor concentration giving 50 per cent inhibition) for tetraethylpyrophosphate (TEPP) is $5{\cdot}2 \times 10^{-9}$ *M* and for dimethylamido-ethoxy-phosphoryl cyanide (Tabun) $2{\cdot}0 \times 10^{-9}$ *M*. The corresponding values for the acetylcholinesterase from human erythrocytes are $3{\cdot}2 \times 10^{-8}$ *M* and $3{\cdot}95 \times 10^{-9}$ *M* respectively.

The results show that the thrombocytes of different animals contain a cholinesterase and that this esterase is an acetylcholinesterase (acetocholinesterase, "specific" cholinesterase), known to be present in the erythrocytes of most animals. It is pertinent to mention that several authors[3-5] have described the presence of such an esterase also in the plasma of certain animals. We would like to suggest tentatively that thrombocytes may be one of the probable sources of this enzyme in the plasma.



Activity–*pS* curves for the thrombocyte acetylcholinesterase of different animals. Substrate: acetylcholine chloride. ○, cat; ●, rat; ×, rabbit; □, dog; △, horse; +, cat thrombocytes in the presence of $1{\cdot}43 \times 10^{-2}$ *M* choline chloride

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Identification of Enteramine, the Specific Hormone of the Enterochromaffin Cell System, as 5-Hydroxytryptamine

Enteramine is the specific secretion or storage product of the typical enterochromaffin cells of the gastrointestinal mucosa of Vertebrata and Ascidia (hence the name 'enteramine'), of the chromaffin cellular elements of the posterior salivary glands of Octopoda and of the hypobranchial body of Muricidæ, as well as of at least a part of the chromaffin granular cells of the cutaneous glands of Amphibia. In all its occurrences, enteramine appears to be identical.

Chemically speaking, the specific product of the enterochromaffin cells was considered by histologists,

at different times, as an *o*-dihydroxybenzene or a *m*-dihydroxybenzene derivative. Already in 1946, however, one of us[1] had emphasized the probable indolic nature of the substance, on the basis of chemical and biological data.

With the development of our investigations (histochemical researches; paper chromatographic work on enteramine extracts with localization and identification of enteramine spots, and successive spectrophotometric, chemical and pharmacological study of the eluates of such spots; demonstration of the presence of enteramine in the skin of Amphibia, which is the most important site for the elaboration or storage of hydroxyindolalkylamines), the probability of the indolic nature of enteramine became a certainty. We therefore decided to attempt its synthesis, while still working on the isolation, in a pure state, of the natural product.

Our efforts were successful. Enteramine has now been isolated, as a pure picrate, from extracts of posterior salivary glands of *Octopus vulgaris* and from extracts of the skin of *Discoglossus pictus*. Almost at the same time the substance was obtained synthetically, also as a picrate. The two specimens of natural enteramine picrate were exactly the same, and identical with 5-hydroxytryptamine picrate which we obtained synthetically, starting from 5-methoxyindole (5-methoxyindole → 5-methoxyindolyl-β-acetonitrile → 5-methoxytryptamine → 5-hydroxytryptamine).

Paper chromatography. By using as solvents *n*-butanol saturated with *N* hydrochloric acid, *n*-butanol saturated with water, and *n*-butanol (8 parts) + monomethylamine 25 per cent (3 parts), the spots given by natural enteramine specimens and by synthetic 5-hydroxytryptamine specimens show identical colour reactions and identical R_F values. On 'mixed' chromatograms, uni- and bi-dimensional, the 5-hydroxytryptamine spots are exactly superposed on those of natural enteramine.

Melting point. The synthetic product turns yellow at 160° C., brick-coloured at 190° C., black at 195° C., and melts with decomposition at 196–197·5° C. *Octopus* enteramine has melting point 191–192° C. with decomposition; *Discoglossus* enteramine has melting point 191·5–193° C. with decomposition; the mixture has melting point 193–194° C. with decomposition; and a mixture of the synthetic product with *Discoglossus* enteramine has melting point 192·5–194° C. with decomposition.

Ultra-violet absorption spectrum. It is exactly the same for synthetic 5-hydroxytryptamine and for natural enteramine specimens. In an aqueous solution at *p*H 5–6, the products show an absorption maximum at 2750 A., a shoulder with a second maximum at 2930–2950 A. and a minimum at 2475 A. At *p*H 11·3–11·5, the absorption spectrum shows a remarkable shift of the second maximum (3220 A.).

Elementary analysis.

$C_{10}H_{12}N_2O.C_6H_3N_3O_7.H_2O$ (423·3)				
	Calculated	C 45·39	H 4·05	N 16·55 per cent
Synthetic picrate	Found	45·54	4·09	16·71
Octopus enteramine (picrate)	,,	45·26	4·11	16·63
Discoglossus enteramine (picrate)	,,	45·58	4·14	16·42

Derivatives. During the synthesis of 5-hydroxytryptamine, another well-defined indole derivative was formed and was isolated as a pure picrate (elongated prisms; melting point 222–223° C. with decomposition; elementary analysis, C, 50·43; H, 4·35; N, 15·66; characteristic R_F values on paper chromatograms). An identical product was also obtained from natural enteramine.

Pharmacological actions. Synthetic 5-hydroxytryptamine, *Discoglossus* enteramine and *Octopus* enteramine were tested on the œstrous uterus of the rat and the urinary bladder of the dog, diuresis of hydrated rats, blood pressure of the cat and of the rabbit, nictitating membrane of the cat, and on the heart of molluscs. On all these test-objects the natural products and the synthetic one produced pharmacodynamic responses which were identical.

These investigations will be described and discussed in detail elsewhere. Other enteramine salts are in preparation, and several enteramine-like substances are being studied from both a chemical and a pharmacological point of view.

We consider enteramine to be a true hormone, regulating the flow of circulatory liquids (blood, hæmolymph) through the kidney. In mammals, the substance acts primarily and specifically on the contractile structures of the afferent vascular bed of the glomerulus, causing their spasm.

Serotonin, a natural product described and isolated in a pure state by Rapport *et al.*[2,3], and tentatively identified as 5-hydroxytryptamine (the identification was recently confirmed by Hamlin and Fischer[4], through the synthesis of this derivative), is circulating enteramine. The physiological intervention and importance of serotonin in extra-renal local vasoconstrictions have not yet been satisfactorily proved.

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Pharmacological Actions of Synthetic 5-Hydroxytryptamine (Serotonin, Thrombocytin)

Recently[1,2] we reported the actions of serum vasoconstrictor, partially purified by the method of M. M. Rapport[3]. The evidence at the time strongly indicated that all the pharmacological actions which were shown by our preparations were due to a single substance—the vasoconstrictor of serum—and supported Rapport's finding that the active substance was an indolalkylamine. Having, through the kindness of Dr. Rapport, obtained a few milligrams of 5-hydroxytryptamine synthesized by a group at the Upjohn Chemical Co., we have been able to confirm that this product has all the actions which we described for the partially purified material.

These actions are as set out below: the doses referred to are those which gave definite responses of the various test objects and are expressed in terms of the free base. The synthetic salt is the creatinine sulphate. (1) Contraction of the spiral strip of sheep carotid artery in a dose of 0·03–0·5 μgm. antagonized by yohimbine and potentiated by cocaine. (2) Contraction of the guinea pig jejunum (0·05–0·5 μgm.),

the mouse jejunum (0·05–1·0 μgm.) and the rabbit jejunum (0·1 μgm.). (3) Contraction of the rat uterus (0·1–1·0 μgm.). The above-mentioned organs were in isolated-organ baths 10 ml. in volume; the intestinal strips and uteri show tachyphylaxis to repeated doses.

(4) Contraction of the nictitating membrane and constriction of the pupil on injection of 0·5–5 μgm. into the carotid artery of the decerebrate cat with divided third cranial nerves and cervical sympathetics.

(5) Liberation of adrenaline on injection into the cut stump of the superior mesenteric artery of the eviscerated cat (0·4–2 μgm.). This is important because tryptamine itself does not have this action, whereas with this exception all the actions of the partially purified material were mimicked by tryptamine.

(6) The uterus of the non-pregnant adrenalectomized cat relaxed on the intravenous injection of 24 μgm. or on the introduction of 9 μgm. through plastic tubing into the lower thoracic aorta.

(7) Intravenous injection of 22 μgm. into two chloralosed cats caused a brief period of apnœa and slight bronchoconstriction, as evidenced by an increase in the range of variation of the intrapleural pressure with a normal or decreased respiratory excursion.

(8) When injected into the femoral artery of the intact cat, 1 μgm. caused a decrease in outflow from the hind limb.

(9) Doses ranging from 12 to 44 μgm. had a pressor action on intravenous injection into the chloralosed cat. The pressor action is weaker than one would have anticipated from its vasoconstrictor action, and is usually preceded and followed by depressor phases. In one experiment (24 μgm.), the rise separating the two depressor phases did not reach the initial level of blood pressure. The depressor phases occur irrespective of whether the vagi are intact or divided; the initial one appears to be due, in part at least, to pulmonary vasoconstriction. Lack of material prevents the elucidation of the second phase; such evidence as we have suggests that it is cardiac in origin.

(10) The intravenous injection of 15–40 μgm. causes a rise of pressure in the pulmonary artery which is weak or absent when injections are made into a pulmonary vein.

(11) Surprisingly enough, although it was anticipated from experiments with crude platelet extracts[4] and with the partially purified serotonin[1], the intradermal injection of 0·02 ml. of 5-hydroxytryptamine in concentrations ranging from 1 in 10^7 to 2 in 10^6 did not cause blanching (in six humans). Indeed, with concentrations of 1 in 10^5 and upwards there may be a red, often morbilliform, reaction without itching or wealing. A striking feature (with concentrations of 1 in 10^5 to 2 in 10^4) in four subjects in which the subcutaneous veins were clearly visible was that they became obliterated within a radius of a few centimetres from the site of injection.

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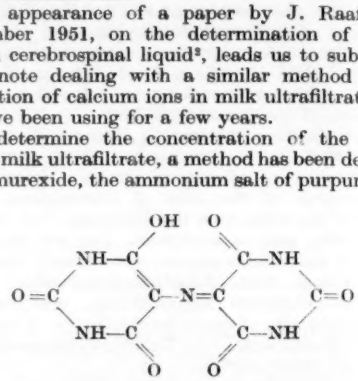
Determination of the Content of Calcium Ions in Milk Ultrafiltrate

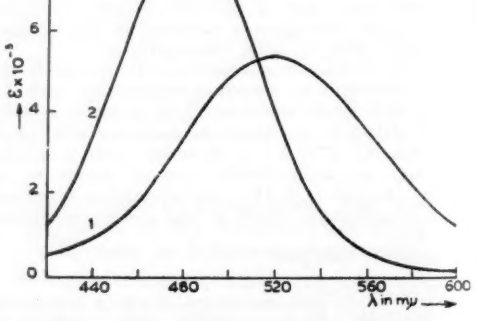
The determination of free calcium ions is very important in human and veterinary pathology and in dairy chemistry. Evidence has been obtained that the instability of milk known as the 'Utrecht abnormality of milk' is caused by an abnormally high level of the concentration of calcium ions[1]. On the other hand, there are some indications that an increased curdling time of milk may be due to a low concentration of calcium ions.

The appearance of a paper by J. Raaflaub in November 1951, on the determination of calcium ions in cerebrospinal liquid[2], leads us to submit this short note dealing with a similar method for the estimation of calcium ions in milk ultrafiltrate which we have been using for a few years.

To determine the concentration of the calcium ions in milk ultrafiltrate, a method has been developed using murexide, the ammonium salt of purpuric acid:



Schwarzenbach and Gysling[3] have described the use of purpurate as a calcium indicator. When a small quantity of calcium ions is added, the colour of a purpurate solution of *p*H 7·5 changes from red–violet to yellow–orange. The graph shows the absorption spectra of purpurate (curve 1) and of the calcium purpurate complex (curve 2). At a wave-length of about 480 mμ the difference in the extinction is largest. Hence this wave-length will be the most favourable for the estimation of the colour change on addition of calcium ions.



Procedure. With a Linderstrøm-Lang micropipette a small, but accurately constant, volume (for example, 50 mm.³) of a 0·1 per cent solution of purpurate is added to each of the following solutions: (1) 2 ml. buffer *p*H 6·4; (2) 2 ml. buffer *p*H 6·4 + 0·2 mol./l. calcium chloride; (*a*) 2 ml. milk ultrafiltrate. The extinction is measured, and the concentration calculated from the following equation:

$$[Ca^{++}] = \frac{1}{K_a'} \frac{E_a - E_1}{E_2 - E_a},$$

where K_a' is the 'association constant' (the reciprocal of the dissociation constant) of the calcium purpurate complex; E_1 is the extinction of solution 1; E_2 of solution 2; E_a of solution a, with a correction for the extinction of the ultrafiltrate without purpurate. K_a' can be determined by the same method, when a calcium solution of a known concentration is taken instead of the ultrafiltrate. The value of K_a' is about 250 at an ionic strength $\mu = 0{\cdot}08$. The concentration of calcium ions of forty samples of normal cow milk was determined. The values obtained ranged from 2·0 to 3·6 m.mol./l., with an average of $2{\cdot}75 \pm 0{\cdot}39$ m.mol./l. (= $11 \pm 1{\cdot}6$ mgm. per cent).

Full details of the method and its theoretical background will be published elsewhere[4]. The study of the application of the method to blood ultrafiltrate has been undertaken.

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Molybdenum Deficiency in Lettuce

Molybdenum deficiency in lettuce has been reported by Brenchley and Warington[1] for water-culture experiments. In Australia, Wilson[2] has shown that a response in growth was obtained in the field by applying a solution of sodium molybdate to the foliage of chlorotic lettuces.

The lettuce experiment reported here was carried out at a field centre known to give molybdenum-deficiency in cauliflower[3]. Plot layout was in the form of a randomized block with threefold replication of treatments. The soil is derived from the Lower Greensand and has an acid reaction. Lettuce (var. Borough Wonder) was sown on January 3, 1951, under Dutch lights, adjacent to the experimental plot. Planting out commenced on March 29, 1951, and the plants were cut for market from June 20 to the end of the month. Treatments, yields and the molybdenum contents of the foliage are shown in the accompanying table.

Yields and Molybdenum Contents of Lettuce

Treatment	Soil *p*H	Yield (cwt. per acre)	Molybdenum (p.p.m.) in dry matter of leaves
Control	5·2	32	0·06
Gypsum, 3 tons per acre	4·9	24	0·06
Ground limestone, 3 tons per acre	6·3	59	0·09
Ground limestone, 6 tons per acre	6·4	56	0·14
Sodium molybdate, 2 lb. per acre	5·4	45	0·08
Sodium molybdate, 4 lb. per acre	5·2	64	0·08
Gypsum, 3 tons per acre plus sodium molybdate, 2 lb. per acre	5·0	62	0·10
			S.E. 0·03

(*a*) Lettuce showing severe molybdenum deficiency; (*b*) lettuce growing on plots given sodium molybdate 4 lb. per acre

The symptoms of molybdenum deficiency observed—chlorosis, necrosis and general stunting of growth—were similar to those already reported[1,2]. The remarkable response of the lettuce to sodium molybdate at 4 lb. to the acre is shown in the accompanying illustration.

The yield increases due to treatments involving either ground limestone or sodium molybdate were roughly doubled (see table) compared with the mean of the control and gypsum treatment. While the molybdenum content of the lettuce leaves was increased by ground limestone or sodium molybdate treatments, the increments are scarcely significant. On the other hand, the gross uptake of molybdenum by the larger crops from these treatments is considerably greater than that of the control.

This experiment confirms the general experience that the correction of molybdenum deficiency can be successfully carried out by raising the soil *p*H to a level when molybdenum becomes available. The investigation will be reported more fully at a later date.

The work was carried out under the special scheme for the investigation of mineral deficiencies of crops, organized and financed by the Agricultural Research Council, to which thanks are due.

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Effect of Auxins on the Mycelial Growth of *Fusarium oxysporum* var. *cubense*

Hawker[1] recently pointed out that although 3-indolylacetic acid is present in most fungi, its effect on growth-rate has not been convincingly demonstrated. An investigation of this reported inactivity has been made in the course of a study on the nature of the biochemical factors in the soil which influence the growth of the fungal inhabitants.

The two auxins tested were 3-indolylacetic acid and 3-indolylacetonitrile. The nitrile was recently isolated from cabbage leaves[2] and was kindly supplied by Prof. E. R. H. Jones. The test fungus used

Fig. 1. Inhibition of mycelial growth by 3-indolylacetonitrile. The position of the crystal plant appears on the photograph as a small white area to the right of the colony

was *Fusarium oxysporum* var. *cubense* Wollenweber and Reinking.

A preliminary qualitative examination was made by planting small crystals (0·25 c.mm.) of each test substance in separate plates each containing 10 ml. of a rich glucose – ammonium agar medium[2]. These plates were inoculated at the centre with hyphal tips of the fungus, the crystal being 35 mm. from the inoculum.

After seven days at 25° C. both the auxin plates showed a flattening of the colony periphery on the side adjacent to the crystal. The nitrile had a stronger inhibitory effect than the acid. With phenol (C_6H_5OH), scarcely any distortion of the colony occurred.

For the quantitative investigation, solutions in 2 per cent alcohol were used. The 800 mgm./l. solution was prepared by dissolving 80 mgm. of the auxin in 2 ml. of absolute alcohol to which water was slowly added with constant shaking until the solution volume was 100 ml. Dilutions were made from this solution using 2 per cent alcohol. Sterilization was unnecessary due to the short-term nature of the method[3]. This consisted simply of inoculating the centres of a series of plates containing 10 ml. of agar medium with hyphal tips of the fungus. After 48 hr. at 25° C. the colony diameters were measured and 5 ml. of test solution added to the agar surface. These plates were then incubated for a further 22 hr. and the diameters remeasured. This revealed the auxin effect on the phase of active mycelial growth. The experiment was carried out on the rich agar medium mentioned above and on a starvation medium of 2 per cent agar, using 3-indolylacetic acid, 3-indolylacetonitrile and phenol as test substances.

On the rich medium both auxins have a stronger fungitoxic effect than phenol. Swelling and bursting of the hyphal tips accompany complete inhibition by 800 p.p.m. of 3-indolylacetonitrile, indicating that part at least of the action is on the wall.

On the starvation medium there is a reduction in fungitoxicity at high concentrations and the appearance of a slight stimulatory effect at low concentrations. It does seem that the rate of auxin synthesis is not a limiting factor for growth on nutrient media but may be growth-limiting on starvation media due to the scarcity of available nitrogen compounds. The absence of a large stimulatory effect on plain agar may be due to the fact that agar contains complex nitrogen compounds, including growth factors[4], so that even here auxin synthesis may proceed at an appreciable rate. 800 p.p.m. of 3-indolylacetonitrile is again completely inhibitory; but there is no distortion of the hyphal tips.

Jones and co-workers[2] noted that 3-indolylacetonitrile was more physiologically active than the acid in the *Avena* straight-growth test. Similarly, the nitrile has a much greater effect on mycelial growth than the acid. This is surprising, since in other cases (formonitrile, acetonitrile, proprionitrile, succinonitrile, benzonitrile) the substitution of the nitrile for the carboxylic group results in a loss of fungitoxicity[5].

The fungitoxicity of these two auxins may be of importance in applied mycology. 3-Indolylacetic acid occurs in the fungi and in seeds, and 3-indolylacetonitrile production seems to be a general property of the Cruciferæ. Thus, these auxins may be present in the soil, and their effect on the fungal population

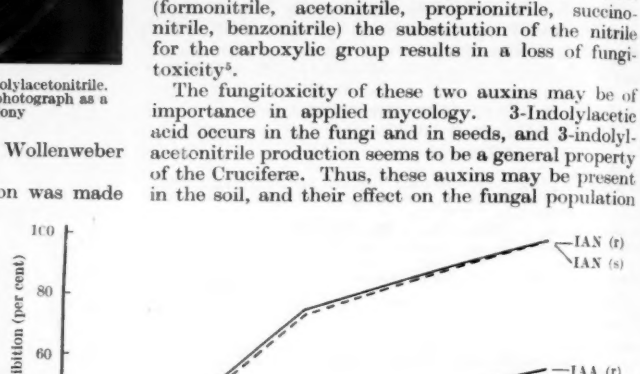

Fig. 2. The effect of auxins on mycelial growth. IAA, 3-indolyl-acetic acid; IAN, 3-indolylacetonitrile; (r), rich agar medium; (s), plain agar medium

may be considerable under certain conditions. Also, it is well known that fungal infection does not occur at plant apices, and the high concentration of auxin here may be significant. There is evidence that phenols and alkaloids may confer immunity to fungal attack[6,7].

I am indebted to Prof. C. W. Wardlaw for suggesting this investigation and for his encouragement on many occasions.

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[6] Greathouse, G. A., and Rigler, N. E., *Amer. J. Bot.*, **27**, 99 (1940).
[7] Greathouse, G. A., and Rigler, N. E., *Phytopath.*, **30**, 475 (1940).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, May 12

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—"Spitsbergen, 1951".

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Eugenics Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. L. E. J. Brouwer: "Outline of Intuitionism" (Shearman Memorial Lectures).* (Further Lectures on May 16, 19 and 23.)

Tuesday, May 13

CHADWICK PUBLIC LECTURE (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 2.30 p.m.—Mr. E. L. Sturdee: "Food and Health".*

ROYAL SOCIETY OF MEDICINE, EXPERIMENTAL MEDICINE AND THERAPEUTICS SECTION (at 1 Wimpole Street, London, W.1), at 5.30 p.m.—Discussion on "Certain Agents used in Milling and Baking" to be opened by Dr. J. B. M. Coppock, Dr. T. Moran and Prof. A. C. Frazer).

Wednesday, May 14

PHYSICAL SOCIETY, COLOUR GROUP (at the Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 3.30 p.m.—Discussion on "The Visual Problems in Colour Television".

ROYAL PHOTOGRAPHIC SOCIETY, COLOUR GROUP (at the Imperial College of Science and Technology, South Kensington, London, S.W.7), at 3.30 p.m.—Discussion on "Visual Problems in Colour Television".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. G. M. Lees, F.R.S., and Mr. D. C. Ion: "The Distribution of Oil Reserves in the World".

ROYAL STATISTICAL SOCIETY, STUDY SECTION (at the E.L.M.A. Theatre, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Discussion on Economic Indices for 1952.

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6 p.m.—Sir Edward Mellanby, F.R.S.: "Medical Research—its Methods, Problems and Social Significance, 1, History, Methods, Individual and Organized Research" (Newsholme Lectures).* (Further Lectures on May 15 and 16.)

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 3.30 p.m.—Mr. E. G. Stroud and Mr. W. H. J. Vernon: "The Prevention of Corrosion in Packaging".

Thursday, May 15

NUTRITION SOCIETY (at the Linnean Society, Burlington House, Piccadilly, London, W.1), at 2.15 p.m.—Annual General Meeting; at 3.30 p.m.—Scientific Meeting.

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. C. F. A. Pantin, F.R.S.: "The Elementary Nervous System" (Croonian Lecture).

INSTITUTION OF MINING AND METALLURGY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. H. S. M. Coxeter, F.R.S.: "Regular Honeycombs in Elliptic Space".

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Sir Joseph Kay: "India's Cotton Textile Industry".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Annual General Meeting.

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Annual General Meeting; Mr. F. C. Warr: Chairman's Address.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. J. Carmichael: "Animal-Man Relationship in Tropical Diseases in Africa".

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 8 p.m.—Dr. Ralson Paterson: "Studies in Optimum Dosage" (Twenty-ninth Mackenzie Davidson Memorial Lecture).

Friday, May 16

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 5 p.m.—Mr. J. Home Dixon: "Radar Chart-Matching Devices".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. Linus C. Pauling, For.Mem.R.S.: "The Structure of Proteins".

Saturday, May 17

BRITISH PSYCHOLOGICAL SOCIETY, SOCIAL PSYCHOLOGY SECTION (in the Department of Psychology, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Prof. R. B. Cattell: "Experiments in Leadership and Synergy in Small Groups".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER or ASSISTANT LECTURER IN MATHEMATICAL STATISTICS, and a RESEARCH ASSISTANT IN NUMERICAL ANALYSIS—The Registrar, The University, Liverpool (May 17).

READERSHIP IN PHYSICS at St. Thomas's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 19).

ASSISTANT LECTURERS IN THE DEPARTMENT OF CHEMISTRY—The Secretary, Queen's University, Belfast (May 20).

ASSISTANTS (2) IN THE DEPARTMENT OF CHEMISTRY, to work mainly on the physical and inorganic side of the subject—The Secretary, The University, Aberdeen (May 20).

DIRECTOR OF INSPECTION (METALLURGICAL) at Tatanagar—The High Commissioner of India, General Department, India House, Aldwych, London, W.C.2, quoting 4/66A (May 20).

READERSHIP IN BIOLOGY at St. Thomas's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 20).

EXPERIMENTAL OFFICERS or ASSISTANT EXPERIMENTAL OFFICERS IN THE PLANT-BREEDING AND ENTOMOLOGY SECTIONS, and a PLANT BREEDER (Scientific Officer grade)—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (May 26).

CHAIR OF ZOOLOGY at Birkbeck College—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 28).

LECTURER IN AGRICULTURE, to assist in the development of the new Honours Degree in Agriculture (lecturing responsibilities will cover Crop Husbandry and Farm Management)—The Registrar, Wye College, Wye, Ashford, Kent (May 31).

LECTURER IN MATHEMATICS at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 31).

PRINCIPAL RESEARCH OFFICER and a RESEARCH OFFICER (graduates in organic chemistry, biochemistry or microbiology; experience of research connected with food preservation and processing a recommendation)—The Fishing Industry Research Institute (University of Cape Town), P.O. Box 1233, Cape Town, South Africa (May 31).

PRINCIPAL RESEARCH OFFICER or SENIOR RESEARCH OFFICER at McMaster Animal Health Laboratory, Glebe, N.S.W., to take charge of a small research unit and to carry out research on helminth physiology and toxicology—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3809 (May 31).

PROFESSOR OF BIOCHEMISTRY—The Secretary, University College, Cork (May 31).

READERSHIP IN PHILOSOPHY at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 31).

RESEARCH OFFICER (Physical Chemist) IN THE BIOCHEMISTRY UNIT, Wool Textile Research Laboratory, Melbourne, to investigate the surface properties and reactions of protein films and related problems of protein chemistry—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3835 (May 31).

RESEARCH SCHOLARSHIPS AND POSTGRADUATE STUDENTSHIPS IN ARTS, SCIENCE AND ECONOMICS—The Registrar, University College, Leicester (May 31).

SENIOR GENETICIST to continue the genetic and cytogenetic studies of the cotton plant started by the Corporation some 25 years ago, and to integrate these with the cotton-breeding programme in the Sudan—The Secretary, Empire Cotton Growing Corporation, 12 Chantrey House, Eccleston Street, London, S.W.1 (May 31).

WELLCOME FELLOWSHIP for whole-time research in connexion with veterinary science or practice—Dr. W. R. Wooldridge, Animal Health Trust, 232–235 Abbey House, Victoria Street, London, S.W.1 (June 10).

LECTURERS IN CIVIL ENGINEERING: (*a*) Civil Engineering (Structures), (*b*) Civil Engineering (Soil Mechanics and Road Engineering), (*c*) Geodesy and Railway Engineering, at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 15).

PROFESSOR OF GEOLOGY AND MINERALOGY at the University of Adelaide, South Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 30).

PROFESSOR OF PURE MATHEMATICS at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 30).

PROFESSOR OF STATISTICS at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 31).

ASSISTANT (Grade B) to teach PHYSICS at the advanced level of the General Certificate of Education, and an ASSISTANT (Grade A) to teach PHYSICS at Ordinary National Certificate level, in the Department of Applied Science, Wolverhampton and Staffordshire Technical College—The Clerk to the Joint Education Committee, Education Offices, North Street, Wolverhampton.

EXPERIMENTAL OFFICER at an out-station of the Royal Aircraft Establishment in Woodbridge, Suffolk, to lead a section engaged on the application of radar to ballistics and other trials—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.131/52 A.

GRADUATE CHEMIST or PHYSICIST for slag-refractory problems in connexion with iron and steel making—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting 'Slags'.

HONOURS GRADUATE IN PHYSICS for fundamental and applied research on fish preservation by smoking and drying; and an HONOURS GRADUATE CHEMIST or BIOCHEMIST, and an ASSISTANT, for fundamental and applied research on low-temperature preservation of foods—The Secretary, Herring Industry Research Board, 1 Glenfinlas Street, Edinburgh 3.

PHYSICISTS AND ELECTRICAL ENGINEERS (Experimental Officer grades) at a Ministry of Supply research establishment near Sevenoaks with knowledge and experience in (*a*) electronic circuit design with

particular reference to V.H.F. region or pulse technique, (*b*) experimental and developmental trials of equipment, including field trials, (*c*) development of electromechanical devices, (*d*) measurement of transient phenomena in connexion with electrical and explosive equipments, (*e*) radio for telemetry work, (*f*) design of aircraft radar; some experimental flying will be required, (*g*) development work on electrical components, preferably with experience of component design or inspection—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, W.C.1, quoting D.170/52A.

Reader in the Department of Soil Science and Chemistry, and a Reader and a Senior Lecturer in the Agricultural Department—The Secretary, Imperial College of Tropical Agriculture, at Trinidad, B.W.I., or 40 Norfolk Street, London, W.C.2.

Scientific and Technical Staff (with university degrees or equivalent qualifications) for research and development of gyroscopes and instruments involving their use; Designers for design and engineering of large modern high-speed wind tunnel, etc.: Staff for research on compressors, combustion and simulated altitude testing connected with gas turbine and jet-engine machinery; Instrument Technicians, Installation Designers and Draughtsmen for the development and installation of special instruments and instrumentation systems in aircraft; at the National Aeronautical Establishment of Canada, Ottawa—The Chief Scientific Liaison Office, National Research Council of Canada, Africa House, Kingsway, London, W.C.2.

Senior Lecturer in Physics, to teach up to B.Sc. (Special) Degree standard—The Clerk to the Governing Body, Northern Polytechnic, Holloway, London. N.7.

Vice-Chancellorship of the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Carnegie Trust for the Universities of Scotland. Fiftieth Annual Report (for the Year 1950–51) submitted by the Executive Committee to the Trustees on 25th February 1952. Pp. iv+68. (Edinburgh: Carnegie Trust for the Universities of Scotland, 1952.) [63

Proceedings of the British Society of Animal Production, 1951. Edited by I. L. Mason. Fifteenth Meeting (London, March 1951), The Incidence and Control of Bovine Mastitis; Sixteenth Meeting (Stratford-on-Avon, September 1951), Livestock Production from Grassland in the West Highlands. Pp. 142. (Edinburgh: British Society of Animal Production, c/o King's Buildings, 1952.) 10*s*. [63

University of London: University College. Annual Report 1950–1951. Pp. 168. (London: University College, 1952.) [63

Imperial Forestry Institute: University of Oxford. Twenty-seventh Annual Report 1950–51. Pp. 30. (Oxford: Imperial Forestry Institute, 1952.) [63

Manchester Museum: The University, Manchester. Report of the Museum Committee for the Year 1950–51. Pp. 28. (Manchester: Manchester Museum, 1952.) [63

Liverpool Observatory and Tidal Institute. Annual Report 1951. Pp. 16. (Liverpool: Liverpool Observatory and Tidal Institute, 1952.) [63

Department of Scientific and Industrial Research: Food Investigation. Leaflet No. 14: A Ten-stone Controlled Fish-smoking Kiln. By Dr. C. L. Cutting and A. Bannerman. Pp. 6+2 plates. (London: H.M. Stationery Office, 1951.) 9*d*. net. [63

British Library of Political and Economic Science. Annual Report 1950–51. Pp. 22. (London: London School of Economics and Political Science, 1951.) [103

Ministry of Labour and National Service. The Worker in Industry: a Series of Ten Centenary Lectures delivered during Festival of Britain Year 1951. Pp. vi+106. (London: H.M. Stationery Office, 1952.) 3*s*. 6*d*. net. [103

A System of Labels for Gassing Casualties sent to Hospitals. Pp. 48. (London: Association of British Chemical Manufacturers, 1952.) 3*s*. [103

Kirkstall Abbey Excavation. Second Report 1951. Pp. 13–28+plates 3–4. (Leeds: Thoresby Society, 1952.) 1*s*. [103

Negretti and Zambra, Ltd. Report and Accounts 1951. Pp. 16. (London: Negretti and Zambra, Ltd., 1952.) [103

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 882, Vol. 244: Some Gravity Wave Problems in the Motion of Perfect Liquids. By J. C. Martin, W. J. Moyce, W. G. Penney, A. T. Price and C. K. Thornhill. Pp. 231–334. 26*s*. No. 883, Vol. 244: Further Observations on the Turbulent Fluctuations in a Tidal Current. By K. F. Bowden and L. A. Fairbairn. Pp. 335–356. 5*s*. (London: Cambridge University Press, 1952.) [103

Royal Technical College, Glasgow. Report on Research, Session 1950–51. Pp. 48. (Glasgow: Royal Technical College, 1952.) [103

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 633, Vol. 236: Jurassic Ammonites from Jebel Tuwaiq, Central Arabia. By W. J. Arkell; with Stratigraphical Introduction by R. A. Bramkamp and M. Steineke. Pp. 241–313+plates 15–31. (London: Cambridge University Press, 1952.) 40*s*. [103

University of Cambridge: School of Agriculture. Memoir No. 23: A Summary of the Papers published by the Members of the Staff of the School of Agriculture and its Associated Research Organisations during the Period Oct. 1st, 1950—Sept. 30th, 1951; Review Series No. 6: Agricultural Economics at Cambridge, 1896–1951. Pp. 31. (Cambridge: School of Agriculture, 1952.) 2*s*. 6*d*. [103

Papers from the Geological Department, Glasgow University. Vol. 23 (Octavo Papers of 1947–1950). (Glasgow University Publications, 88.) Pp. vii+17 papers. (Glasgow: Jackson, Son and Co., 1951.) [103

Other Countries

Organisation for European Economic Co-operation. Technical Assistance Mission No. 63: The Control of Livestock Diseases in European Countries. Pp. 80. (Paris: Organisation for European Economic Co-operation; London: H.M. Stationery Office, 1952.) 250 francs; 5*s*. [6

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Bureau Climatologique, Communication No. 3: Chutes de pluie au Congo Belge et au Ruanda-Urundi pendant la décade 1940–1949. Pp. 248. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1951.) [6

Bulletin of the World Health Organization. Supplement 3: Medical Certification of Cause of Death; Instructions for Physicians on the Use of International Form of Medical Certification of Cause of Death. Pp. 20. (Geneva: World Health Organization; London: H.M. Stationery Office, 1952.) 1*s*.; 20 cents; 0.75 Swiss francs. [6

New Zealand Forest Service. Annual Report of the Director of Forestry for the Year ended 31st March 1951. Pp. 79. (Wellington: Government Printer, 1951.) 1*s*. 6*d*. [6

University of California. Anthropological Records, Vol. 13, No. 4: Kuanyama Ambo Folklore. By E. M. Loeb. Pp. 285–336. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1951.) 50 cents. [6

Scientific Institutions and Scientists in Latin-America. Pers Vol. 1. Pp. iii+105. (Montevideo: Unesco Centro de Cooperación Científica para America Latina, 1951.) [6

Bulletin of the Illinois Natural History Survey. Vol. 25, Article 4: Biology of the White Crappie in Illinois. By Donald F. Hansen. Pp. 211–266. Vol. 25, Article 5: Commercial and Sport Fishes of the Mississippi River between Caruthersville, Missouri and Dubuque, Iowa. By Paul G. Barnickol and William C. Starrett. Pp. 267–35 (Urbana, Ill.: Illinois Natural History Survey, 1951.) [6

State of California: Department of Fish and Game, Bureau of Marine Fisheries. Fish Bulletin No. 81: Purse Seines and other Roundhaul Nets in California. By W. L. Scofield. Pp. 83. Fis Bulletin No. 82: A Comparison of the Populations of Yellowfin Tuna *Neothunnus macropterus*, from the Eastern and Central Pacific. H. C. Godsil and E. C. Greenhood. Pp. 33. (Terminal, Calif.: Stat Fisheries Laboratory, 1951.) [6

The Reform of the Indian Calendar. By M. N. Saha. Pp. 2 (Calcutta: Indian Science News Association, 1952.) [6

Government of Hyderabad. Annual Administration Report of th Department of Mines and Geological Survey for the Year 1949–5 Pp. v+59. (Hyderabad: Government Press, 1951.) 3.8 rupees. [6

Proceedings of the American Academy of Arts and Sciences. Vol. 8 No. 2: Biographical Digests 4, Centennials and Polycentennials durin 1952 with Interest for Chemists and Physicists. By Ernest H. Hun ress. Pp. 33–100. (Boston, Mass.: American Academy of Arts an Sciences, 1952.) [6

Bulletin of the American Museum of Natural History. Vol. 9 Article 3: A Revision of the Genus *Annaphila* Grote (Lepidoptera Phalaenidae). By Frederick H. Rindge and Claude I. Smith. Pp 187–256. 1 dollar. Vol. 98, Article 4: Revision of the Nearctic Speci of the Pompilid Genus *Pepsis* (Hymenoptera, Pompilidae). By Pa David Hurd, Jr. Pp. 257–334. 1 dollar. (New York: America Museum of Natural History, 1952.) [10

Smithsonian Institution: Bureau of American Ethnology. Bulleti 146: Chippewa Child Life and its Cultural Background. By Sister M Inez Hilger. Pp. xiv+204+31 plates. (Washington, D.C.: Govern ment Printing Office, 1951.) 75 cents. [10

Illinois Natural History Survey. Biological Notes No. 25: Com mercial Fisheries of Illinois Rivers; a Statistical Report for 195 By William C. Starrett and Sam A. Parr. Pp. 36. (Urbana, Ill Illinois Natural History Survey, 1951.) [10

Indian Forest Leaflet No. 124: Indigenous Cellulosic Raw Materia for the Production of Pulp, Paper and Board, Part 2, Pulps for Writi and Printing Papers from the Castor Oil Plant (*Ricinus communis*) By Dr. R. V. Bhat and Narendra S. Jaspal. Pp. ii+15. (Delhi Manager of Publications, 1951.) 8 annas; 9*d*. [10

Indian Forest Bulletin No. 145: Pulping of Illuk Grass (*Imperata arundinacea*) by Soda and Mono-Sulphite Processes. By Chatt Singh and Dr. S. R. D. Guha. Pp. ii+10. 8 annas; 9*d*. Indi Forest Bulletin No. 152: Indigenous Cellulosic Raw Materials for t Production of Pulp, Paper and Board, Part 3, Semi-chemical a Chemical Pulps from *Lannea grandis* (*jhingan*). By Dr. R. V. Bhat an Dr. S. R. D. Guha. Pp. ii+16. 14 annas; 1*s*. 3*d*. (Delhi: Manag of Publications, 1951.) [10

Chicago Natural History Museum. Popular Series, Zoology, No. 1 The Truth about Snake Stories. By Karl P. Schmidt. Second editio Pp. 23. (Chicago: Chicago Natural History Museum, 1951.) cents. [10

East African Agriculture and Forestry Research Organisation: Origin and Objects. By Dr. B. A. Keen. Pp. 12. Annual Repo 1950. Pp. ii+57. (Kikuyu: East African Agriculture and Forest Research Organisation, 1951.) [10

Kongelige Danske Videnskabernes Selskab. Biologiske Meddelelser Bind 21, Nr. 7: The Rheology of the Cross Striated Muscle Fibr with particular reference to Isotonic Conditions. By Fritz Buchth and E. Kaiser, in collaboration with Poul Rosenfalck. Pp. 31 (København: Ejnar Munksgaard, 1951.) 35 D. cr. [10

Commonwealth Scientific and Industrial Research Organizatio Bulletin No. 262: Soils of the Margaret–Lower Blackwood Rive Districts, Western Australia. By R. Smith. Pp. 51. Bulletin No. 263 Pasture Development on a Deep Sand of the Heath Country in th Upper South-East of South Australia. By A. J. Anderson and C. Neal-Smith. Pp. 31+3 plates. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1951.) [10

Gold Coast. Report on the Forest Department for the Year 1950 51. Pp. 24. (Accra: Government Printing Department; London: Crown Agents for the Colonies, 1951.) 2*s*. 6*d*. [10

Portugaliae Acta Biologica. Série A: Volume R. B. Goldschmid Pp. xvi+882. (Lisboa: Instituto Botânico da Faculdade de Ciencia 1949–51.) [10

Fourth Annual Report of the Pacific Marine Fisheries Commissio for the Year 1951. Pp. 16. (Portland, Oregon: Pacific Marine Fisheri Commission, 1952.) [10